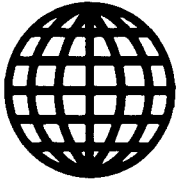


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# ***JPRS Report***

# **Science & Technology**

***USSR: Materials Science***

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SCIENCE & TECHNOLOGY  
USSR: MATERIALS SCIENCE

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PHASE AND STRUCTURAL CONVERSIONS IN TITANIUM ALLOYS CONTAINING HYDROGEN

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA  
in Russian No 1, Jan-Feb 87 (manuscript received 10 Jan 86) pp 96-101

[Article by A. A. Ilin, Moscow Aviation Technological Institute, Department  
of Metal Science and Heat Treatment Technology]

[Abstract] The basic data from the literature of the past 10 years and experimental results obtained by the author on the phase and structural conversions in titanium alloys containing hydrogen are summarized using alloys in the Ti-V-H system as a convenient example. It is found that increasing hydrogen content can significantly change the phase composition and structure of alloys after hardening and at certain concentrations convert them to a new class of alloys. Martensitic class alloys can be converted to transitional class 'pseudo- $\beta$  class alloys by addition of hydrogen. This new method of treating titanium alloys, including addition of hydrogen and heat treatment, can control the structure of titanium alloys over broad limits. This thermohydrogen treatment may yield changes based on hydrogen-phase hardening or control of generation of the  $\alpha$ -phase upon breakdown of the hydrogen-containing  $\beta$ -phase. The final operation is always vacuum annealing under conditions selected to product the desired properties. Referenees 16: 12 Russian, 4 Western (1 in Russian translation).

6508/9835

CSO: 1842/132

EXTRACTION-PHOTOMETRIC DETERMINATION OF THALLIUM IN SEMICONDUCTOR SINGLE CRYSTALS

Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 53, No 2, Feb 87  
(manuscript received 2 Apr 86) pp 10-11

[Article by Ya. S. Balog, P. P. Kish, Ya. R. Bazel and Ye. Yu. Peresh,  
Uzhgorod State University]

[Abstract] The purpose of this work was the development of a reliable, selective method for extraction-photometric determination of thallium using a cyanine dye - cationic pink 2C. It was found that, in the presence of bromide ions, thallium (III) forms ionic associates with the dye in a sulfate medium which can be extracted by aromatic hydrocarbons and acetic aliphatic esters. The influence of acidity of the medium, concentration of bromide ions and the dye, contact time and relationship of volumes of aqueous and organic phases on degree of extraction of thallium were studied to determine the optimal conditions for formation and extraction of the ionic associates. The course of the analysis process is described. The method is highly sensitive and selective and can be successfully used to determine thallium in other complex systems including chalcogenide glasses and environmental objects. References 5: all Russian.

6508/9835  
CSO: 1842/115

SURFACE PROPERTIES OF QUARTZ GLASS AS A VACUUM STRUCTURAL MATERIAL FOR THERMONUCLEAR INSTALLATIONS

Moscow FIZIKA I KHIMIYA OBRABOTKI METALLOV in Russian No 2, Mar-Apr 87  
(manuscript received 3 Jul 86) pp 72-76

[Article by L. B. Begrambekov, A. M. Zakharov, V. A. Kurnayev, N. N. Koborov,  
V. G. Telkovskiy, A. A. Pisarev, Yu. V. Fedorov and V. N. Tsyplakov, Moscow]

[Abstract] Experiments were performed on the suitability of quartz glass for use as a structural material exposed to high vacuums in thermonuclear installations. Liberation of sorbed gases, capture of ions, erosion, change in composition and surface topography and the parameters of reflected particle fluxes were studied. Bombardment of the glass with hydrogen or helium ions at approximately 600-700°C did not change the structure, relief or physical and chemical properties of fused quartz. Bombardment of the surface with the products of atomization of stainless steel produced shallow cylindrical pits and whiskers. The coefficient of reflection of ions by the

quartz was lower than that of most other structural materials. The hydrogen ion capture coefficient was approximately the same as most hydrogen-inactive metals, and liberation of interstitial hydrogen occurred at much higher temperatures than in other materials. Ion bombardment at over 800°C resulted in great liberation of oxygen and structural transformation of the fused quartz in a layer 1-2 orders of magnitude deeper than the penetration of the ions, increasing the conductivity of the surface and altering its sorption properties. References 7: 5 Russian, 2 Western,

6508/9835  
CSO: 1842/144

UDC 669.295-176

#### RECRYSTALLIZATION AND TEXTURING IN VT15 TITANIUM ALLOY

Moscow METALLY in Russian No 2, Mar-Apr 87 (manuscript received 29 Jul 85)  
pp 93-96

[Article by G. V. Turchaninova, R. A. Adamesku, A. S. Shishmakov and  
M. O. Litovskikh, Sverdlovsk]

[Abstract] Studies were performed on hot-rolled strips, 5 mm thick, annealed at 850°C for 1 hour with subsequent cooling in air, producing blanks with 100% content of  $\beta$  phase. Cold rolling was performed with compression of 30, 48 and 70% in one direction. Specimens were annealed at temperatures 40°C above the beginning of recrystallization and held 3 to 180 minutes, with subsequent cooling in water. The volumetric fraction of recrystallized material was determined with an accuracy of 1%. Texture was studied in deformed sheets and after annealing, providing 50 and 100% recrystallization. The formation of recrystallization texture was found to be basically completed in the early stages of the process. The major recrystallization texture component in the alloy studied is (211) [011]. References 7: 6 Russian, 1 Western.

6508/9835  
CSO: 1842/131

## TITANIUM HYDRIDE DISSOCIATION PRESSURE

Moscow METALLY in Russian No 2, Mar-Apr 87 (manuscript received 12 Jun 85)  
pp 41-44

[Article by V. N. Fadeyev, L. A. Izhvanov and L. F. Yeremina, Moscow]

[Abstract] A study of the dissociation pressure of titanium hydride at 400-625°C was performed for single-phase hydrides containing 3.46 mass percent H and two-phase hydrides obtained by decomposition of the single-phase hydride to 2.0-2.8 mass percent H. The maximum deviation in pressure from the equilibrium value corresponding to the compact hydride was observed for the material T-1, pure titanium hydride powder, possibly due to the influence of impurities, evaporation or interaction of moisture sorbed by the powder surface with the hydride, or processes related to the dispersion of the material. The influence of each factor is discussed. The hydrogen pressure over titanium hydride with high dispersion, particle size less than 20  $\mu\text{m}$ , was found to be two-three times higher than the equilibrium pressure over compact hydride. Reduction of oxide forms of titanium by atomic hydrogen on the developed powder surface is considered to be the most probable cause. References 9: 6 Russian, 3 Western (2 in Russian Translation).

6508/9835

CSO: 1842/131

## RHEOLOGICAL CHARACTERISTICS OF SPHERICAL POWDERS OF NICKEL AND STAINLESS STEEL

Kiev POROSHKOVAYA METALLURGIYA in Russian No 4, Apr 87 (manuscript received 8 Apr 86) pp 33-37

[Article by R. A. Andriyevskiy and V. P. Levin, Physics Institute, Kirgiz Academy of Sciences; All-Union Scientific Research, Planning-Design and Technological Institute of Chemical and Petroleum Machine Building]

[Abstract] A study is made of the internal and external friction characteristics of spherical metallic nickel and stainless steel powders as functions of the fractional composition. Experiments were performed on a direct shear installation at 1 mm/min. The rheological characteristics were computed by calculating the force required to break down a specimen of bulk material by shear deformation while simultaneously recording the normal compacting load. Values of the internal friction angle and angle of repose are presented for PCN nickel and PRKh18N9 stainless steel powders produced by spraying of liquid melts. Particle size has little effect on internal friction. The range of values of external friction is almost the same for



both materials, being somewhat narrower than the range of internal friction in the stainless steel, somewhat broader in the nickel powder, probably influenced by the surface state of the particles. References 9: 3 Russian, 6 Western (1 in Russian translation).

6508/9835

CSO: 1842/157

UDC 539.216.2:535

#### OPTICAL PROPERTIES OF TITANIUM NITRIDE OBTAINED BY LASER RADIATION

Kiev SVERKHTVERDYIE MATERIALY in Russian No 2, Feb-Mar 87 (manuscript received 10 Jul 85) pp 23-26

[Article by B. A. Atamanenko, M. U. Belyy, P. I. Drozd, V. V. Lendel, G. G. Tsebulya and I. A. Shaykevich, Superhard Materials Institute, Ukrainian Academy of Sciences; Kiev State University]

[Abstract] A study was made of the optical properties of titanium nitride synthesized by laser radiation. Specimens were produced by interacting laser radiation with titanium in a nitrogen-containing medium; by powder metallurgy methods; and by condensation of the substance in a vacuum with ion bombardment. Synthesis by means of laser radiation was found to produce coatings of titanium nitride in a time of approximately 1 millisecond. The material is assumed to have superior crystalline structure in comparison to titanium nitride synthesized by the other methods. References 12: 6 Russian, 6 Western.

6508/9835

CSO: 1842/155

UDC 621.981+621.762

SPECIFIC FEATURES OF STRUCTURE AND WEAR MECHANISM OF TUNGSTEN-FREE COMPOSITE POWDER DETONATION COATINGS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 3, Mar 87 (manuscript received 28 Oct 85) pp991-95

[Article I. G. Nosovskiy, V. V. Shchepetov and V. Kh. Kadyrov, Kiev Higher Military Aviation Engineering School]

[Abstract] Powders of type PKh20N80 nichrome and PKh23N15 austenitic stainless steel were used as initial materials for tungsten-free composite coatings produced by detonation. The friction characteristics of these coatings were studied to obtain equivalent replacements for traditional tungsten-containing hard alloys. Antifriction properties were achieved by changing the chemical composition of the initial powder materials by additional alloying with boron and aluminum by diffusion. The optimal content of alloying elements, producing the maximum wear resistance of the coatings, was determined. Maximum wear resistance was achieved with nichrome-based coatings. Wear intensity was determined largely by the properties and characteristics of the oxide films formed, complex and difficultly activated structures consisting of spinel-type compounds based on oxides of the metals contained in the coatings. During plastic deformation occurring with friction, the surface layer of the coatings is converted to a thermodynamically non-equilibrium activated state, forming heterophase thin-film NiO, Cr<sub>2</sub>O<sub>3</sub> and Al<sub>2</sub>O<sub>3</sub> structures on the surface which shield the base material. The use of wear resistant coatings of composite powders applied by detonation methods can improve quality, reliability and durability of dry friction couples in machines and mechanisms while reducing the consumption of tungsten. References 5: 4 Russian, 1 Western (in Russian translation).

6508/9835

CSO: 1842/124

## LASER-PLASMA SYNTHESIS OF TITANIUM AND ZIRCONIUM NITRIDES

Moscow FIZIKA I KHIMIYA OBRABOTKI METALLOV in Russian No 2, Mar-Apr 87  
(manuscript received 26 Sep 86) pp 88-91

[Article by A. A. Uglov, M. B. Ignatyev and I. Yu. Smurov, Moscow]

[Abstract] A study is made of the specific features of the structure and phase structure of nitride compounds synthesized by laser-plasma treatment of titanium and zirconium. X-ray structural studies of metals following combined laser-plasma treatment in an atmosphere of high pressure nitrogen have established that, at pressures of over  $2 \cdot 10^6$  Pa and laser radiation flux density over  $10^{10}$  W/m<sup>2</sup>, nitride compounds of stoichiometric composition are formed on the surface. This article studies the nature of the change in the x-ray diffraction diagrams of the initial specimen after laser-plasma treatment in an atmosphere of nitrogen at  $5 \cdot 10^6$  Pa with pulsed neodymium laser radiation in free generation mode ( $\tau = 1$  ms,  $q = 4 \cdot 10^{10}$  W/m<sup>2</sup>) and in modulated Q mode ( $\tau = 50$  ns,  $q = 10^{11}$  W/m<sup>2</sup>). In both cases, nitride compounds were formed on the surface. The thickness of the nitride layer varied with nitrogen pressure, reaching a maximum at an intermediate pressure. The nitrided layers formed upon bombardment of titanium in a high pressure chamber consisted of a layer of titanium of columnar-dendritic structure and a narrow dark band of  $\epsilon$  phase or a mixture of  $\epsilon + \alpha$  and  $\epsilon + \text{TiN}$  phases, followed by a lighter, softer layer, corresponding to a solid solution of nitrogen in  $\alpha$ -titanium. Increasing pressure causes an increase in the total thickness of the layer and of the  $\epsilon$ -phase layer, while the solid solution layer decreased, disappearing completely at about  $6 \cdot 10^6$  Pa. References 5: all Russian.

6508/9835

CSO: 1842/144

UDC 621.793.7

## STRUCTURE AND PROPERTIES OF GAS-THERMAL COATINGS OF THE ALLOYS Fe-B-C and Fe-Ti-B-C

Kiev POROSHKOVAYA METALLURGIYA in Russian No 4, Apr 87 (manuscript received 24 Jan 86) pp 50-56

[Article by Yu. S. Borisov, V. Ye. Oliker, Ye. A. Astakhov, V. N. Korzhik and Yu. A. Kunitskiy, Institute of Materials Science Problems, Ukrainian Academy of Sciences]

[Abstract] Results are presented from studies of the structure and certain properties of gas-thermal coatings of  $\text{Fe}_{61}\text{B}_{37}\text{C}_2$  and an alloy of similar composition containing titanium:  $\text{Fe}_{67}\text{Ti}_{17}\text{B}_{24}\text{C}_2$ . Coatings 0.2-0.4 mm thick were applied to copper and steel substrates by plasma sputtering using powders measuring 50-100  $\mu\text{m}$ . In the powders with titanium, the major segregations

were  $TiB_2$  and some of the boron was replaced with carbon.  $TiC$  containing boron was also present in insignificant quantities. The layered structure was also more clearly expressed in the coatings containing titanium and porosity was lower. Within the layers were a light colored amorphous matrix with inclusions of  $\alpha$ -Fe with microhardness of 11,000-14,000 MPa, and the  $TiB_2$  segregation. The alloy with Ti had much greater bond strength with the substrate and higher wear resistance. References 10: 9 Russian, 1 Western.

6508/9835

CSO: 1842/157

UDC 621.762

#### PHASE COMPOSITION OF DETONATION COPPER-MOLYBDENUM DISULFIDE COATINGS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 4, Apr 87 (manuscript received 6 Jan 86) pp 72-75

[Article by V. M. Temkin, V. V. Vlasenko, B. A. Podolskiy, T. P. Baldina and V. V. Gruzlov, Kharkov]

[Abstract] A study is made of the phase composition of coatings produced from various mechanical mixtures of copper with molybdenum disulfide atomized by various detonating gas mixtures. The coatings were produced of mechanical mixtures containing 5-15%  $MoS_2$ , remainder Cu. Coatings were applied to AK4-1 aluminum alloy with a modernized detonation installation. The phase composition of the coatings was studied by x-ray diffraction. At 10% or more  $MoS_2$  in the initial powder, a trend is noted toward decreasing  $MoS_2$  content in the coating with increasing volumetric relationship of detonating gases over 1.2. X-ray diffraction analysis of the distribution of molybdenum disulfide showed nonuniform distribution, with higher content at the center of the atomization spot. References 5: 4 Russian, 1 Western (in Russian translation).

6508/9835

CSO: 1842/157

COMPOSITE MATERIALS

UDC 678.01:539.4

FRACTOGRAPHICAL ANALYSIS OF DUCTILE FRACTURE OF THERMOPLASTIC BINDER MATERIALS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 6, Nov-Dec 87  
(manuscript received 17 Jan 86) pp 963-968

[Article by M. K. Petrosyan, Yu. M. Tovmasyan, I. G. Kuznetsova and V. V. Kovriga, Plastmassy Scientific-Production Association, Moscow; Norplast Scientific-Production Association, Moscow; Chemical Physics Institute, USSR Academy of Sciences, Moscow]

[Abstract] Ductile fracture of high-viscosity thermoplastic binder materials such as polybutylene terephthalate and polycarbonate is analyzed on the basis of fractograms taken under a JEOL scanning electron microscope, fracture of these materials being characterized by prior formation of conical "crater" cracks. Interpretation of the fractograms, covering a wide range of temperatures and cracking rates, takes into account deformation and relaxation processes. Causes and mechanisms of fracture as well as location of fracture centers are revealed. Evidently spontaneous vibrations build up, resulting in jumpwise fracture along with formation of fibrils and films which smooth the fracture process. References 11: 6 Russian, 5 Western.

2415/9835  
CSO: 1842/114

UDC 539.3:678.067

AVERAGING OF PROPERTIES OF HYBRID FIBROUS COMPOSITE MATERIALS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 6, Nov-Dec 87  
(manuscript received 26 Mar 86) pp 1011-1016

[Article by M. G. Gringauz, G. P. Starikovskiy, L. A. Filshtinskiy, A. M. Kharchenko, S. P. Shapovalov, and V. T. Shcherbakov, Kharkov Polytechnic Institute imeni V. I. Lenin, Sumy Branch; Obninsk Tekhnologiya Scientific-Production Association]

[Abstract] For design and performance analysis of new hybrid fiber-reinforced composite materials, the method of averaging their properties is extended to

calculation of their state of stress and elasticity characteristics without restriction to one kind of fiber. First a typical repetitive structural element is extracted, whereupon the theory of elasticity and the mathematical apparatus of the function of a complex variable are used for solving applicable bi-periodic problems for generalized plane deformation and longitudinal shear. The algorithm is executed numerically after integral equations have been reduced to systems of algebraic ones in unknown densities by the method of mechanical quadratures. Implementation of this method is demonstrated on the practical and general case of irregular structures with randomly distributed inclusions, assuming a statistically uniform distribution of the latter. Numerical calculations are made and results are shown for a hybrid composite material with unidirectionally oriented fibers having an elliptical cross-section and then specifically for a plastic material with boron-glass reinforcement. References 13: 12 Russian, 1 Western (in Russian translation).

2415/9835

CSO: 1842/114

UDC 539.4:678.067

#### DEPENDENCE OF FRACTURE OF CARBON-PLASTICS ON DISSIPATIVE CHARACTERISTICS OF BINDER

Riga MEKhanika Kompozitnykh Materialov in Russian No 6, Nov-Dec 87  
(manuscript received 6 Jan 86) pp 1021-1028

[Article by V. Ye. Yudin, A. M. Leksovskiy, G. Kh. Narzullayev, B. A. Zaytsev, L. N. Korzhavin and S. Ya. Frenkel, High Molecular Compounds Institute, USSR Academy of Sciences, Leningrad]

[Abstract] A composite material consisting of carbon fibers and polymer binder is considered for an analysis of the fracture dynamics and dependence of the latter on the dissipative characteristics of the binder. The strength of such a composite material is known to depend in an ambiguous manner on the elasticity of the binder, the correlation between them being close at higher temperatures but the variance of the former being large even when the variance of the latter is small at normal temperatures. An experimental material was produced by soaking LU-1 carbon ribbons in EDT-10 epoxy resin at a temperature of 373 K for 0.5 hours and then hot pressing at temperatures of 413 K and 433 K for 2 hours. Specimens with a 0.45 volume fraction of binder, 0.5-0.6 mm thick and 10 mm wide were cut to 100 mm gauge length for testing. The dynamic mechanical characteristics of the binder had been determined with glass fibers in the form of two model composite materials, "rolivsan" A and "rolivsan" B with different relaxational transitions. The dynamic modulus of elasticity and the damping coefficient of the binder were measured under periodic excitation at a frequency of 72 Hz. Fracture of the epoxy-carbon composite material was subsequently recorded on the basis of acoustic emission signals and tracked on photographs depicting the surface of specimens. The data have been processed with the aid of an M6000 computer. An analysis of the results with the aid of applicable reference material

yields a close correlation between strength of the composite and binder characteristics over a temperature range including glass transition of the binder (373-450 K) and higher, when energy dissipation in the binder is taken into account. References 16: 15 Russian, 1 Western.

2415/9835  
CSO: 1842/114

UDC 624.074:678.067

METHOD OF CALCULATING RELIABILITY OF IMPERFECT CYLINDRICAL MULTILAYER SHELLS  
WITH VARIANCE OF STRENGTH CHARACTERISTICS OF COMPOSITE MATERIAL TAKEN INTO  
ACCOUNT

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 6, Nov-Dec 87  
(manuscript received 26 Jun 86) pp 1043-1048

[Article by S. P. Yushanov, Polymer Mechanics Institute, LaSSR Academy of  
Sciences, Riga, and A. Ye. Bogdanovich, Latvian State University  
imeni P. Stuchka, Riga]

[Abstract] The probability of failure is calculated for a real and thus imperfect cylindrical multilayer shell, a monolayer as a macrovolume being described by a vector random stress field characterizing its quality and determinable from the solution to the corresponding stochastic boundary-value problem according to the theory of random functions with outshoots. The solution is obtained in the "strip" approximation and assuming a low probability of failure, with the strength distribution function experimentally determinable. The solution yields the standard deviations of quality vector components and the reliability criterion as functions of time for tensile stresses and for compressive stresses, first assuming a determinate strength surface and then allowing for a given variance of tensile or compressive strength. Even a small variance of the stress tensor component most likely to overshoot its allowable level is found to appreciably lower the reliability of a shell. References 16: all Russian.

2415/9835  
CSO: 1842/114

PECULIARITIES OF DEVELOPMENT OF VISCOELASTIC PROPERTIES IN COMPOSITE MATERIALS  
BASED ON FLEXIBLE-CHAIN POLYMERS AND CONTAINING FILLERS WITH VARIOUS DEGREES  
OF ACTIVITY

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 6, Nov-Dec 87  
(manuscript received 8 Jan 86) pp 1073-1080

[Article by Yu. G. Yanovskiy, G. V. Vinogradov and V. V. Barancheyeva,  
Petrochemical Synthesis Institute imeni A. V. Topchiyev, USSR Academy of  
Sciences, Moscow]

[Abstract] The rheological characteristics of linear flexible-chain polymers such as polybutadiens with a narrow molecular-mass distribution and with an active filler are analyzed, including the temperature dependence as well as deformation-rate and loading-frequency dependence of their viscoelasticity. An experiment was performed with 1,4-cis-polybutadiene having a molecular-mass mode of  $1.35 \cdot 10^5$  and a polydispersity factor of 1.05, highly active structurizing and strengthening acetylene black (specific surface  $67 \text{ m}^2/\text{g}$ , 20:1 fiber length-to-diameter ratio) or less active kaolin (specific surface  $10 \text{ m}^2/\text{g}$ ) or aluminum globules (specific surface  $0.4 \text{ m}^2/\text{g}$ ) being added as filler material. Specimens of these composites with the filler weight fraction ranging from 5% to 65% were produced by cold rolling. Measurements were made by the dynamic method of small-amplitude periodic forced shear deformation, within the linear range, and using a mechanical dynamic-polymer-characteristics spectrometer. These measurements yielded the dynamic complex shear modulus  $G^*$  as well as the storage modulus  $G'$  and the loss modulus  $G''$  representing respectively elastic and dissipative characteristics of the material, as functions of loading frequency as well as their temperature and filler-weight-fraction dependence. An evaluation of the data reveals the effect of filler on these moduli and indicates the "yield strength" of each polybutadien-filler combination. References 9: 8 Russian, 1 Western.

2415/9835  
CSO: 1842/114

EFFECT OF HUMIDITY AND LOW TEMPERATURES ON PROPERTIES OF POLYMER AND COMPOSITE  
MATERIALS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 6, Nov-Dec 87  
(manuscript received 22 Jan 86) pp 1101-1104

[Article by T. A. Starzhenetskaya and I. N. Cherskiy, Physical Technical  
Problems of the North Institute, Yakutsk Branch, Siberian Department, USSR  
Academy of Sciences, Yakutsk]

[Abstract] Two classes of polymer and composite materials, water-repelling and water-attracting ones, were studied in a year-round experiment under



atmospheric conditions in Yakutsk, where the temperature drops to  $-64^{\circ}\text{C}$  and the mean-annual relative humidity of the air does not exceed 67%. Polyethylenes did not gain mass, but their properties changed depending on the season (April, October) and on the humidity level during each. Phenol aldehydes sorbed all an approximately equal small amount of moisture over a period of 2-3 years. High-impact polystyrenes, thermoplastic polyurethanes, and glass-plastics gained mass in April and lost mass in winter. For the purpose of estimating the stability of materials in cold humid air and thus predicting their resistance to fracture during crystallization of water sorbate in such a climate, there has been developed a method involving measurement of the water sorption rate twice, first with the material in the initial dry state and then with the material in the final frozen state, the ratio of the two readings serving as indicator of frost resistance. After this method had been tested on those five groups of materials, it was used for evaluation of four other materials: PA-610 polyamide, PA-610 polyamide with 30% fine glass needles, AG-4V thermosetting phenol formaldehyde with 38% randomly distributed glass fibers, GSP-16 thermosetting formaldehyde with 36% braided glass fibers. Plain polyamide PA-610 was found to have the highest frost resistance, with a zero increase of the water sorption rate upon transition from dry to frozen state. The results of mechanical tests for strength under a static flexural load correlate with the water sorption data. Temperature cycling over the  $20^{\circ}\text{C}$ - $(-60)^{\circ}\text{C}$  span was found to increase the strength of PA-610 polyamide and even more so the strength of glass-filled PA-610 polyamide, while decreasing the strength of both glass-filled thermosetting phenol formaldehydes. References 3: all Russian.

2415/9835

CSO: 1842/114

UDC 539.217:539.4:678.067

#### STRENGTH OF A STRUCTURAL COMPOSITE

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 2, Mar-Apr 87  
(manuscript received 10 Jan 86) pp 218-224

[Article by V. A. Frolov]

[Abstract] Short-term anisotropic moisture absorption in the direction of fibers is considered as a measure of the degree of delamination of filler from binder in high-strength structural composites representing the status of the filler-binder interface. This factor is used in a statistical analysis of the strength of composites to yield an estimate of the loss of strength due to time variance of failure of monofilaments of the filler. An equation for composite strength is derived, containing the mean strength of the dry filler, the mean strength of the filler in a monolith with the binder, the fraction of filaments not in good contact with the binder, and a parameter representing the time variance of monofilament failure. An experimental method is suggested for estimating the quantity of filler with

disrupted filler-binder contact, based on capillary saturation.  
References 6: all Russian.

6508/9835  
CSO: 1842/160

UDC 539.25:678.01:678.067

STRUCTURE AND PROPERTIES OF EPOXY CHLORINE-CONTAINING POLYMER CURED BY  
ACTIVE CARBON FIBER

Riga MEKhanika Kompozitnykh Materialov in Russian No 2, Mar-Apr 87  
(manuscript received 8 Jan 86) pp 231-235

[Article by V. I. Dubkova, I. N. Yermolenko, A. I. Burya and V. T. Dorofeyev,  
General and Inorganic Chemistry Institute, Belorussian Academy of Sciences,  
Minsk; Dnepropetrovsk Agricultural Institute; Dnepropetrovsk Chemical  
Technology Institute imeni F. E. Dzerzhinskiy]

[Abstract] A unique peculiarity of phosphorus-containing carbon fiber - epoxy oligomer systems is that the reaction beginning at the surface of the fibers propagates into the space between fibers, into the volume of the binder, converting the composite material to an insoluble monolith, meaning that the fibers can act as a curing agent. This article presents results of investigation of the structure and properties of an epoxy chlorine - containing polymer cured by phosphorus-containing carbon fibers. Materials were analyzed by differential-thermal analysis, dynamic thermogravimetry, infrared spectroscopy, chemical analysis, etc. The studies showed that the diglycide chlorine-containing ester underwent complex chemical conversions resulting in its curing when jointly heat treated with the fibers. Curing occurred with the direct participation of active groups from the surface of the fibers. Changes in the supermolecular structure of cured epoxy oligomer with increasing distance from the fiber surface are traced, revealing a transition layer with morphology different from both the fiber and the resin. Mechanical testing revealed superior compressive strength and workability. The strength is equal to that of other epoxy composites reinforced with carbon fibers.  
References 8: all Russian.

6508/9835  
CSO: 1842/160

## ELASTIC CHARACTERISTICS OF RANDOMLY HETEROGENEOUS COMPOSITE MATERIALS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 2, Mar-Apr 87  
(manuscript received 5 Feb 86) pp 243-249

[Article by M. I. Gay, E. S. Zelenskiy, L. I. Manevich, V. G. Oshmyan,  
V. I. Sochnev, Z. P. Sulyayeva and R. A. Turusov, Chemical Physics  
Institute, USSR Academy of Sciences, Moscow; Norplast Scientific-Production  
Association, Moscow]

[Abstract] A previous article has suggested a new geometric model of a composite material, based on a percolation description of the structure of the material, i.e., possible consideration of the formation and disappearance of clusters of rigid or soft material. An important feature of this model is the possibility of predicting sharp increases or decreases in effective composite rigidity over a narrow band of concentrations. This article is intended to test for the existence of such sharp changes in elastic characteristics in actual composites and to determine the areas of applicability of the percolation ideas. Data are presented from mathematical models of the elastic properties of a material for 3 different percolation systems; experimental data are presented on model flat systems are also presented. The equations indicate that a sharp increase in the effective modulus of elasticity of the material is observed in the area of 40% filler for a square grid, 50% for a hexagonal grid and 10% for a cubic grid. These values agree well with the percolation thresholds for a square grid with two coordination spheres, a simple triangular grid and cubic grid with 3 coordination spheres. The experimental results show a qualitative change in the nature of deformation in the 40-60% filler content range. The percolation peculiarities of composite structures may influence the mechanical properties of the structures, though the question of the universality of the percolation mechanical behavior of composites remains open. References 21: 8 Russian, 13 Western (2 in Russian translation).

6508/9835

CSO: 1842/160

## NEW ASPECTS OF FRACTURE KINETICS OF POLYMER AND COMPOSITE MATERIALS EXPOSED TO ULTRAVIOLET RADIATION

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 2, Mar-Apr 87  
(manuscript received 31 Mar 86) pp 262-269

[Article by V. A. Belyy and L. S. Koretskaya, Metal Polymer Systems  
Mechanics Institute, Belorussian Academy of Sciences, Gomel]

[Abstract] The purpose of this work was to study the changes in the properties of polymer materials under the influence of UV radiation; to establish the interrelationship between durability of materials exposed to UV radiation and the physical structure of the polymers and to determine the mechanism of formation of defects. Periodic exposure to UV radiation causes reversible deformation of polymer films under load as a result of changes in temperature in the specimens. The reversibility of the deformations and the existence of the compression effect allows a new analysis of the process of failure of materials and estimation of the kinetics of defect formation and crack development. During aging, the orientation changes in a polymer material at the molecular and supermolecular levels, increasing internal stresses, producing defects and microscopic cracks. Stable molecular and supermolecular structures are needed to assure reliability and durability of the polymer component in composite materials. The most promising and effective method of increasing the durability of heterogeneous systems is the creation of a gradient of physical and mechanical properties in the materials, perhaps by formation of multifunctional polymer layers on metal, ceramic or wood. Effective stabilizers are those compounds which stabilize polymers without changing the energetic conditions of formation of equilibrium macromolecular conformations in heterogeneous systems. Such stabilizers double or triple the durability of coatings. References 9: all Russian.

6508/9835  
CSO: 1842/160

## THERMAL STRESS IN SPIRAL WOUND COMPOSITE RODS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 2, Mar-Apr 87  
(manuscript received 18 Feb 86) pp 305-309

[Article by G. Ye. Freger, B. B. Ignatyev, V. V. Chesnokov,  
N. A. Karvasarskaya and A. M. Panfilov, Voroshilovgrad Machine Building  
Institute]

[Abstract] A study is made of the thermal deformation of a rod element equal in length to one complete turn of the spiral winding. The thermal stresses

and deformations in the structure of the circular rod element are calculated as functions of the types of materials used and winding angle of the reinforcing filament. Calculations are performed for a 2 mm diameter rod as it cools from 120°C to 20°C. The results of the studies indicate the possibility of directed regulation of the value of thermal stress and strain in rod elements and composites with spirally wound reinforcement by selection of the materials of the winding layers, their dimensions and winding angles. The greatest values of stress and strain occur with near-zero winding angles. A reduction in stress can be achieved by the use of low-modulus fine filaments. By alternately winding in opposite directions, the deformation of the product can be almost completely eliminated. References 6: all Russian.

6508/9835  
CSO: 1842/160

UDC 678.02:678.067

#### TECHNOLOGY OF FORMATION OF GRADIENT REINFORCED MATERIALS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 2, Mar-Apr 87  
(manuscript received 17 Jun 86) pp 315-320

[Article by B. I. Natrusov, T. Ye. Shatskaya, V. A. Lapitskiy, Yu. N. Smirnov and B. A. Rozenberg, Stekloplastik Scientific-Production Association, Moscow Oblast; Chemical Physics Institute, USSR Academy of Sciences, Moscow]

[Abstract] The manufacture of composites using presaturated reinforcing materials places limits on the types of binder which can be used. A new technology in Soviet practice is the creation of presaturated materials with practically unlimited life by separate application of the binder components to the reinforcing elements with subsequent combination by alternation in the process of forming the products (separate application of components or SAC method). The SAC method not only increases the storage life of presaturated components, but also decreases the time and temperature of formation of products by the use of components with high reactivity. The SAC method has been tested in the manufacture of products by contact compaction, vacuum molding and winding. The process of curing propagates frontally through products manufactured by the SAC method as the resin and curing agents on different reinforcing elements mutually diffuse into each other. Internal stresses arising in glass-reinforced plastics due to differences in the coefficients of thermal expansion of binder and glass filler play an important role in the process, increasing with increasing compaction time. The polymer matrix structure facilitates processes of stress relaxation in areas adjacent to the fiber-matrix interface, increasing shear strength and decreasing density and resistance to corrosive media. References 2: both Russian.

6508/9835  
CSO: 1842/160

STUDY OF INTERACTION OF MATRIX WITH FIBER IN COMPOSITE MATERIALS BASED ON  
NICKEL AND CHROMIUM

Moscow FIZIKA I KHTIMIYA OBRABOTKI METALLOV in Russian No 2, Mar-Apr 87  
(manuscript received 6 Dec 85) pp 114-117

[Article by A. V. Shulga and V. V. Nikishanov, Moscow]

[Abstract] A study is presented of the interaction of nickel, chromium and nichrome matrices with fibers of the refractory metals tungsten and molybdenum. Fiber composite materials were obtained by hot vacuum molding at 1100°C for 15-30 minutes. The kinetics of the interaction of the matrix with the fiber were studied by annealing at 1200-1600°C with holding up to 100 hours. Specimens for metallographic investigation were prepared by electrolytic etching in 10% NaOH and 10% oxalic acid. X-ray microspectral analysis was also performed. It was found that the least intensive interaction occurred in Cr-W specimens. Formation of metallographically visible boundaries of the interaction zone resulted from recrystallization of the fibers, recrystallization of the matrix and formation of a zone of diffusion porosity and phase boundaries. Figures 3; references 5: 4 Russian, 1 Western (in Russian translation).

6508/9835

CSO: 1842/144

UDC 669.187.2:669.38:620.197

DEPENDENCE OF CORROSION DEPTH AND SURFACE LAYER STRUCTURE ON Mo CONTENT IN  
Cu-Mo CONDENSATES

Kiev PROBLEMY SPETSIALNOY ELEKTROMETALLURGII in Russian No 1, Jan-Mar 87  
(manuscript received 5 Sep 85) pp 27-30

[Article by V. G. Grechanyuk, V. I. Topal, B. M. Yemelyanov, N. I. Grechanyuk,  
D. K. Zabolotskaya and L. V. Pushechnikova, Construction Engineering Institute,  
Kiev, Electric Welding Institute imeni Ye. O. Paton, UkSSR Academy of Sciences,  
Kiev]

[Abstract] A corrosion study of Cu-Mo composite condensates with varying Mo content was made for the purpose of determining their corrosion resistance in water. Condensates containing 1.1-10.5% Mo as well as of pure Cu were produced by the electron-beam evaporation and vacuum deposition process. The structure of their surface layers were examined under a "Neophot" 21 microscope and their microhardness was measured with a PMT-3 tester. Pitting of the initially columnar structure indicated electrochemical corrosion. The microhardness was found to increase depthwise across the defective layer from a very low level at the surface and the depth of this layer, indicating the corrosion depth, was found to increase with increasing Mo content in the condensate. The corrosion rate was found to be higher in tap water than in distilled water, under static or dynamic conditions. References 9: all Russian.

2415/9835  
CSO: 1842/108

UDC 669.187.2:621.74.04-669.14.018

CENTRIFUGAL ELECTROSLAG CASTING OF PIPELINE TEES

Kiev PROBLEMY SPETSIALNOY ELEKTROMETALLURGII in Russian No 1, Jan-Mar 87  
(manuscript received 9 Sep 85) pp 3-5

[Article by B. Ye. Paton, B. I. Medovar, V. L. Shevtsov, V. V. Lakomskiy, G. S. Marinskiy, N. N. Samokhvalov and V. I. Dregolyuk, Electric Welding Institute imeni Ye. O. Paton, UkSSR Academy of Sciences, Kiev]

[Abstract] A method of centrifugal casting of pipeline tees has been developed within a short time on the basis of the well-proven electros slag technology, casting being preferable to forging when the material is a cold-resistant steel such as the 15CrNiSiCu grade. Casting of blanks in a vertical machine is followed by rough machining, heat treatment, hydraulic testing, ultrasonic inspection, and final machining. A special ultrasonic facility has been designed ensuring maximum reliability of the detection of internal flaws. Castings of TRL-250-125 tees with 125 mm nominal duct length for operating pressure of 25 MPa produced by this method meet high-quality requirements of applicable All-Union State Standards. Conversion to this method of casting should save about 300 rubles per ton of finished tees in production cost. References: 1 Russian.

2415/9835

CSO: 1842/108

UDC 669.14.002.612

LOW-CARBON WELDABLE MARTENSITIC STEEL WITH SLIGHT ADDITIVES OF VANADIUM AND NITROGEN

Moscow METALLY in Russian No 3, May-Jun 87 (manuscript received 8 Oct 85)  
pp 88-91

[Article by L. I. Gladshteyn, R. I. Entin, D. A. Litvinenko, L. I. Kogan, L. A. Bobyleva, O. I. Nikolskiy, L. M. Kleyner and M. N. Pankova]

[Abstract] Results are presented from a study of low-carbon martensitic steel type 08Kh4N2MAF containing small quantities of vanadium and nitrogen.



Specimens for mechanical testing were prepared from rolled strips, some of which were tempered, while others were normalized at 900°C, 30 minutes, cooling in air and tempered at 650-660°C, 1.5 hours, cooling in air. The tensile strength was 840-880 MPa, yield point 730-810 MPa, and impact toughness was good down to -60 - 80°C. Up to 0.08-0.15% vanadium and 0.015-0.025% nitrogen increased the tempering resistance of the steel, resulting in the preservation to a great degree of the martensitic sub-structure during high-temperature tempering. The steel is recommended for the manufacture of large welded structures. References 3: all Russian.

6508/9835

CSO: 1842/163

UDC 559.14.018.252.3:621.785.52

#### FORMATION OF THE CARBIDE COMPONENT UPON CARBONIZATION OF HIGH SPEED 02R6M5 STEEL

Moscow METALLY in Russian No 3, May-Jun 87 (manuscript received 26 Nov 85)  
pp 92-95

[Article by V. I. Ivanitsa, V. I. Movchan and L. G. Pedan, Dnepropetrovsk]

[Abstract] A study is made of the formation of the carbide component upon carbonization of low-carbon steel alloyed like type R6M5 steel, (mass. %: C 0.17, # 6.2, Mo 5.5, V 1.7, Cr 3.65, Mn 0.09, Si 0.26, P 0.008, S 0.03). The steel was made in an induction furnace in a crucible with a basic magnesite liner and cast by a centrifugal method into thick sleeves, outside diameter 87 mm, inside diameter 25 mm. It was found possible to control the structure of the carbide component, forming dispersed carbide inclusions or carbides extended in the direction of carbonization. To increase the number of carbide formation centers after rapid cooling from the homogenization temperature the specimens were artificially aged, producing finely dispersed segregations. Heating to the cementation temperature caused the small segregations to dissolve, uniformly enriching the matrix with carbide-forming elements, which supports decomposition of the ferrite during carbonization with the formation of austenite-carbide colonies. References 4: all Russian.

6508/9835

CSO: 1842/163

## PORE FORMATION IN METAL OPERATING AT ELEVATED TEMPERATURES UNDER STRESS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 4, Apr 87 pp 43-45

[Article by Yu. M. Gofman and L. Ya. Losev, Sverdlovenergoremont]

[Abstract] This article studies pore formation in type 12Kh1MF steel during creep. Studies were performed by transmission and scanning electron microscopy and light metallography and density determined. The method of light metallography plus measurement of the density of the metal is the easiest method for most laboratories and was found to be sufficiently reliable for estimation of the damage accumulated by metal specimens. The studies determined the maximum values of damage accumulation above which the metal should not be used. With 0.72% damage accumulation and pore density of 1400 pores/mm<sup>2</sup>, large numbers of pore chains were observed under the light microscope along the boundaries of ferrite grains, as well as individual microscopic cracks, indicating that the metal should be immediately replaced. The maximum safe pore density is about 900 pores/mm<sup>2</sup>, damage accumulation rate 0.4%, at which point the residual durability of the metal is 10-15% of the total time to failure. References 9: all Russian.

6508/9835

CSO: 1842/146

## STRUCTURE AND PROPERTIES OF AUSTENITIC ALLOY DEFORMED UNDER HIGH TEMPERATURE GAS EXTRUSION CONDITIONS

Moscow METALLY in Russian No 3, May-Jun 87 (manuscript received 3 Feb 86) pp 111-114

[Article by A. P. Bashchenko, V. Ye. Vaganov, A. V. Omelchenko, V. D. Berbentsev, V. V. Solovyev and Yu. S. Konyayev]

[Abstract] A study is made of the influence of high temperature gas extrusion conditions on the structure and properties of carbon-containing iron-nickel alloys 25N29 and 50N22 containing 0.25 and 0.5% C and 29 and 22% Ni, respectively. The formation of the structure and mechanical properties at 700-1000°C follows the general regularities of structure formation during hot deformation. The peculiarities of structure and mechanical properties, including the formation of a fine cell substructure and the existence of a strength maximum, result from peculiarities in the stress state at the deformation focus and the deformation scheme. When high temperature gas extrusion is used to strengthen alloys, deformation conditions must achieve fractional deformation. References 4: all Russian.

6508/9835

CSO: 1842/163

PECULIARITIES OF THE STRUCTURE OF ELECTROLYTIC Fe-Ni ALLOYS

Moscow METALLY in Russian No 3, May-Jun 87 (manuscript received 19 Nov 85)  
pp 136-139

[Article by V. V. Poevtkin and I. M. Kovenskiy, Tyumen]

[Abstract] Electrolytic precipitates of alloys about 30  $\mu\text{m}$  thick were obtained on copper cathodes from sulfate electrolytes with total concentration of coprecipitated metal salts equal to 1.25 mol-l. Having dissolved the copper substrate chemically, electropolishing in a standard electrolyte was used to prepare foils about 20  $\mu\text{m}$  thick for Mossbauer spectroscopy and x-ray structural analysis. Electrocrystallization of iron-nickel alloys was found to yield concentration heterogeneities in the precipitates. In alloys containing from 42.5 to 25% Ni, these concentration heterogeneities are clusters of nickel atoms with the same body-centered cubic lattice as the matrix. With nickel content of 25% an intermetallic phase is formed which is not present on the equilibrium constitution diagram of Fe-Ni. References 11: 8 Russian, 3 Western (1 in Russian translation).

6508/9835

CSO: 1842/163

UDC 669.187.2:621.74.043:621.74.002.2

PRODUCTION OF COPPER PLATES BY ELECTROSLAG CHILL CASTING

Kiev PROBLEMY SPETSIALNOY ELEKTROMETALLURGII in Russian No 1, Jan-Mar 87  
(manuscript received 28 May 86) pp 8-9

[Article by A. I. Borodin and A. S. Yevglevskiy, Electric Welding Institute  
imeni Ye. O. Paton, UkSSR Academy of Sciences, Kiev]

[Abstract] Experimental study has confirmed the feasibility of producing high-quality copper plates by electros slag chill casting. Copper charge was melted in a slag bath with a nonconsumable graphite electrode, use of a graphite electrode and a graphite crucible helping to lower the oxygen content in the copper typically from 0.01% to 0.004% or from 0.03% to 0.006%. Molten copper was poured into a steel mold rigidly attached to the crucible. Castings of M1-M3 copper produced by this scheme had neither cavities nor dendritic inclusions, their chemical impurity content being far below the maximum allowable. Their mechanical characteristics were also within specifications. Production of plates weighing 100-300 kg requires an electric energy expenditure of 600-800 kW·h/ton.

2415/9835

CSO: 1842/108

UDC 621.762

INFLUENCE OF TECHNOLOGICAL FACTORS ON PROPERTIES OF COMPACT BRIQUETTES AND PRODUCTS OF TITANIUM SPONGE

Kiev POROSHKOVAYA METALLURGIYA in Russian No 4, Apr 87 (manuscript received 16 Jul 85) pp 28-33

[Article by Ye. S. Obodovskiy and A. M. Laptev, Kramatorsk Industrial  
Institute, Special Design Bureau of Hydraulic Pulse Technology, Siberian  
Department, USSR Academy of Sciences]

[Abstract] A study is made to select thermomechanical conditions for final compaction, heating and stamping of briquettes of sponge titanium in the

manufacture of compact titanium products. The influence of thermomechanical conditions on the properties of the sponge titanium is studied. Initial material used was TG-105 titanium sponge containing the following impurities, %: Fe - 0.04; C - 0.01; Si - 0.01; Cl - 0.05; N<sub>2</sub> - 0.01; O<sub>2</sub> - 0.04. It is recommended that final hot compaction and closed stamping under static or dynamic conditions be performed at 1150-1200°C with a pressure of at least 50 MPa. This technology was used to obtain briquettes 30-110 mm in diameter with height to diameter ratio of 0.7 - 1.5. Extrusion pressure was studied as a function of the drawing coefficient and temperature. The titanium produced was equal in physical and mechanical properties and corrosion resistance to technical titanium produced by the traditional method by melting of titanium sponge. The impurity content satisfied the requirements for type VT1-00 technical titanium. References 6: all Russian.

6508/9835  
CSO: 1842/157

UDC 621.762

#### INTERACTION OF Cr<sub>3</sub>C<sub>2</sub> CARBIDE WITH IRON MATRIX IN THE PRESENCE OF PHOSPHORUS DURING SINTERING

Kiev POROSHKOVAYA METALLURGIYA in Russian No 4, Apr 87 (manuscript received 28 May 86) pp 38-41

[Article by R. A. Vlasyuk, V. P. Smirnov and A. A. Sotnik, Institute of Materials Science Problems, Ukrainian Academy of Sciences]

[Abstract] A study is made of the influence of phosphorus on the process of dissolution of Cr<sub>3</sub>C<sub>2</sub> particles in an iron matrix in order to study the formation of the structure of wear-resistant alloys such as type KKhZh or chromium steels synthesized from a mixture of carbide with iron powder. Interaction of the carbide with the phosphorus-containing iron matrix differs from dissolution of carbide in pure iron or phosphorus-containing nickel. Recrystallization of Cr<sub>3</sub>C<sub>2</sub> to the M<sub>7</sub>C<sub>3</sub> carbide is inhibited at 1100-1280 K. Dissolution of the carbide particles in the iron matrix at 1350-1380 K results in the formation of a crater with a smooth bottom due to crystallization of a carbide eutectic. After the temperature of 1300 K is reached in locations where initial carbide particles were present the phase composition can be represented as the γ-phase and iron phosphides and carbides, the combination of which creates the conditions for formation of the liquid phase and crystallization of the carbide eutectic. A study of the distribution of chemical elements at the locations of the carbide eutectic shows the presence of sectors rich in phosphorus between carbides. Development of the liquid phase accelerates recrystallization of the carbide throughout the volume of a particle so that the excess carbon formed cannot dissolve in the matrix but is concentrated at the boundaries of the phosphorus-rich spherical inclusions. Phosphorus, however, does not facilitate homogenization of the structure. References 6: all Russian.

6508/9835  
CSO: 1842/157

## FORMATION OF DIAMOND-CONTAINING MATERIALS WITH METAL-CARBIDE MATRIX AT HIGH PRESSURES

Kiev POROSHKOVAYA METALLURGIYA in Russian No 4, Apr 87 (manuscript received 5 Feb 86) pp 45-49

[Article by L. F. Stasyuk and I. P. Kushtalova, Superhard Materials Institute, Ukrainian Academy of Sciences]

[Abstract] A study is made of the formation of composites based on type AS20 400/315 synthetic diamonds with a matrix containing adhesion-active metals - titanium and nickel - in a relationship corresponding to a hypoeutectic alloy based on the titanium-nickel state diagram. Some 30% by volume titanium carbide powder was added to the matrix to increase hardness and wear resistance. The volumetric diamond content was 62%. Sintering was performed in a high pressure apparatus at pressures and temperatures in the area of the thermodynamic stability of diamond. In the initial stage of sintering as the pressure was applied the diamond grains were crushed along planes containing the greatest number of inclusions, the matrix being compacted to a pore-free state. As the temperature rose, the appearance of the liquid phase was accompanied by penetration of the binder into cracks in the grains and the catalyst metal dissolved in the matrix. A titanium carbide film holding the diamonds was formed on the grain surface. Oxygen was dissolved in the matrix of the composite and intermetallides and oxycarbides were formed. Breaking of microscopic diamond grains causes self-sharpening of the composite during use. References 12: 11 Russian, 1 Western.

6508/9835

CSO: 1842/157

## MANUFACTURE OF SMALL-MODULUS GEAR WHEELS WITH IRON POWDER HUB

Kiev POROSHKOVAYA METALLURGIYA in Russian No 4, Apr 87 (manuscript received 25 Jun 86) pp 92-93

[Article by V. A. Garenskikh, P. P. Savintsev, A. N. Luzin, A. S. Aminov, N. A. Mikheyeva, and R. S. Fineyeva, Sverdlovsk Precision Mechanics Plant; Raduga Production Association, Metallurgy Institute, Ural Scientific Center, USSR Academy of Sciences]

[Abstract] A study was made of the possibility of manufacturing gear wheels with 0.5 and 0.7 mm modulus and 25 and 27 mm diameter using type PZh4M3 iron powder, as well as a mixture of this powder with a chromium-containing type PKh30 master alloy and type PNE nickel powder. 0.5% zine stearate was added

to the powder to improve compaction conditions. The parts were formed in two stages, first the rim, then the hub. Some wheels were manufactured in one operation, while in others the gears were cut on sintered wheels. Production testing indicated that the new method can increase metal utilization factors by 80%, decreasing labor intensity by 50% and reducing total cost.

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# SPECIFICS OF INTERACTION OF ZIRCONIUM MELT WITH PLASMA CONTAINING HYDROCARBONS

Moscow METALLY in Russian No 3, May-Jun 87 (manuscript received 4 Jun 85)  
pp 32-36

[Article by M. I. Matveyeva, Ye. B. Boyko, O. G. Saliyeva, S. I. Gubenko,  
G. B. Potushinskaya and V. V. Averin, Moscow]

[Abstract] Plasma-arc remelting of zirconium iodide specimens was performed with a direct-action plasmotron in an atmosphere of argon containing 2-8 vol. % methane in a laboratory furnace with holding times of 15-420 sec. The specimen mass was 20 g, bath diameter and depth 25 and 15 mm. The possibility of alloying zirconium with carbon by plasma-arc remelting in an atmosphere of argon with the addition of hydrocarbon-containing gases was demonstrated in principle. Thermodynamic calculation of the composition of the gas phase in the argon-methane system at 500-600 K showed an extreme in the curve of concentration of hydrocarbon-containing components in the products of decomposition of methane as a function of temperature at 3000-4000 K. The distribution of temperatures over the surface of the bath indicated that the gas phase of the zirconium melt was basically Ar, H<sub>2</sub>, H, C<sub>2</sub>H<sub>2</sub>, C<sub>2</sub>H, C, C<sub>2</sub> and C<sub>3</sub>. The thermodynamic conditions required for existence of condensed carbon did not obtain in the central portion over the melt. The rate of carbonization of the melt was linear and varied directly with methane content. Metallographic studies of zirconium melted in an atmosphere of argon with methane showed the possibility of forming several phases: an  $\alpha$ -solid solution, carbide phase, metastable hydride phase with low hydrogen content and carbide phase with hexagonal close-packed structure. References 7:  
6 Russian, 1 Western (in Russian translation).

6508/9835

CSO: 1842/163

## BEHAVIOR OF PLATINUM METALS DURING ELECTROREFINING OF NICKEL

Moscow METALLY in Russian No 3, May-Jun 87 (manuscript received 9 Dec 85)  
pp 37-43

[Article by I. Yu. Davydova, V. V. Distler, Yu. P. Dikov, I. P. Laputina,  
A. I. Gorshkov, Ye. I. Yashkin and A. G. Ryzhov, Moscow]

[Abstract] Results are presented from studies of the structural and chemical state of platinum metals by a combination of physical and chemical analysis methods. Two types of anodes containing rhodium, iridium and ruthenium were studied, one produced from black nickel, the other by melting N-1 cathodic nickel with 0.5% sulfur and 8% copper. Platinum metals were found to be present in a variety of forms in the slime from electrolytic dissolution of nickel: sulfides, oxides, hydroxides. Some of the rare platinoids are present as the elementary form of the individual metal. A probable mechanism is suggested for the formation of fine fractions of slimes containing noble metals. References 16: 13 Russian, 3 Western (1 in Russian translation).

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## FORMATION OF ALLOYS IN THE Mo-Ni-P SYSTEM DURING COMBUSTION

Moscow METALLY in Russian No 3, May-Jun 87 (manuscript received 11 Jun 85)  
pp 210-212

[Article by S. V. Muchnik, V. B. Chernogorenko, Ya. F. Lomnitskaya,  
K. A. Lynchak and L. A. Yanov, Kiev]

[Abstract] This article continues a study of phase formation during combustion of ternary mixtures of phosphorus plus two metals. Specimens were pressed into tablets 15 and 20 mm in diameter to achieve adiabatic combustion conditions. Five of the six known ternary compounds and a solid solution are produced by combustion,  $\text{Mo}_2\text{Ni}_6\text{P}_3$  not being found. By analogy with combustion in the Mo-Fe-P system previously studied, a liquid phase is formed in the first stage. Its composition is close to eutectic Ni-Ni<sub>3</sub>P. It then flows and molybdenum and nickel dissolve forming the compounds, greatly reducing diffusion hindrances related to structuring of the atoms. Phase formation is a specific and rapidly occurring process involving the liquid alloy Ni-P which interacts with molybdenum to form the compounds. References 10: 6 Russian, 4 Western.

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CSO: 1842/163



UDC 621.315.592:548.25

## TEMPERATURE GRADIENT ZONE RECRYSTALLIZATION OF GALLIUM ARSENIDE IN DISCRETE ZONES

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 23, No 2, Feb 87  
(manuscript received 27 Mar 84) pp 181-185

[Article by N. P. Yefremova and V. P. Popov, Novochoerkask Polytechnical  
Institute imeni S. Orzhonikidze]

[Abstract] A method for the temperature gradient zone recrystallization of gallium arsenide in discrete zones was developed. The kinetics of the process and certain unique aspects of the formation of the heterostructure within the crystalline interior were studied. Monocrystalline plates of AGChT or AGChO gallium arsenide ( $1.0 \times 16 \times 20 \text{ mm}^3$ ) with an orientation of (111) or (100) and alloyed with tellurium or tin to a concentration of  $(5-8) \cdot 10^{17} \text{ cm}^{-3}$  were used in all the experiments. The recrystallization was done in a steel water-cooled chamber pressurized with helium  $2 \cdot 10^5 \text{ Pa}$ . The chamber held a flat heating element, the specimen holder, and a system of screens to maintain a uniform temperature gradient (20 to 30 degrees/cm) in the specimen. Pure gallium or gallium alloys were used as the solvent metal. Photolithography was used to make the line zones. The protective mask was a film of either  $\text{SiO}_2$  0.2 mcm thick or natural  $\text{Ga}_2\text{O}_3$  oxide 0.5 mcm thick. The windows in the mask were oriented in the [110] direction. The line zones were formed in a vacuum in a uniform thermal field inside a cylindrical displacement-type holder. When the working temperature was reached, the bath containing the unsaturated solvent metal was shifted at a constant speed of 0.5 cm/s over the specimen's surface, thereby wetting the unprotected surfaces with the metal. Zone movement and recrystallization were studied metallographically, and the electrophysical characteristics of the structures formed were measured. The method described can be used for the stable displacement of line and point zones 20 to 200 mcm in diameter within a temperature range of 820 to 1050 degrees. The shape of the curves representing the relationship between the speed at which the discrete zones move and their thickness and temperature was determined and explained theoretically. The density of dislocations was no higher in the recrystallization zone than in the substrate. The p-n transitions formed at the boundaries between the channels and the original gallium arsenide were of high quality. The use of pure gallium zones made

it possible to obtain channels from which the original Sn admixture could be cleaned and to efficiently clean tin from the original material (2 to 3 orders in both cases). Using silicon as an alloying element provides the opportunity to form multi-layered structures out of the line zones, as there is not a single-sign relationship between the conductivity inversion temperature and the crystallographic orientation of the growing surface. References 6: 3 Russian, 3 Western (1 in Russian translation).

13050/9835  
CSO: 1842/91

UDC 539.129:3

THE DIFFUSION OF Ni, Ga, and As IN THE SURFACE LAYER OF GaAs AND THE CHARACTERISTIC OF THE CONTACT BETWEEN Ni and GaAs

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 23, No 2, Feb 87  
(manuscript received 18 Apr 85) pp 186-189

[Article by V. A. Uskov, A. B. Fedotov, Ye. A. Yerofeyeva, A. I. Rodionov and D. T. Dzhumakulov, Gorkiy State University imeni N. I. Lobachevskiy, Gorkiy Physical Technical Research Institute]

[Abstract] The low-temperature co-diffusion of Ni, Ga and As in a surface layer of gallium arsenide and the effect of this diffusion on the volt-ampere characteristic of rectifying contact between Ni and GaAs were studied. A transitional layer of the Ni--GaAs (100) system ( $n=10^{18} \text{ cm}^{-3}$ ) was formed as a result of 15 minutes of heat treatment at 360 to 870 K in an argon stream. The distribution of the atom concentration in this layer was studied using layer-by-layer radiometry and neutron-activation analysis. Some of the heat-treated specimens that were not irradiated by the neutrons were used to measure the volt-ampere characteristics (VAKh) of contact areas 500 mcm in diameter formed by anodic dissolution of the surface layer. The effective height of the potential barrier was determined from the straight branch of the VAKh. The co-diffusion of the components of the Ni-GaAs system takes place in a field of elastic stresses caused by the difference between the parameters of the lattice formed by the Ni and GaAs, and the intermetallic compounds and their coefficients of thermal expansion. When the temperature of heat treatment was less than or equal to 570 K, the reactive diffusion of the Ni took place when the activation energy was  $(0.51 \pm 0.05)$  electron volts. The formation of microfissures in the surface layers of monocrystalline gallium arsenide reduces this range to  $(0.25 \pm 0.05)$  electron volts. When the heat-treatment temperature exceeded 670 K, internal electrical fields and the complexing process significantly affected the distribution of the components. The shape and the parameters of the volt-ampere characteristic for Ni/GaAs contact were determined by the phase composition and the structure of the transitional layer. References 11: 9 Russian, 2 Western (1 in Russian translation).

13050/9835  
CSO: 1842/91

GROWING  $\text{PbZr}_{1-x}\text{Ti}_x\text{O}_3$  CRYSTALS AND STUDYING THEIR DEGREE OF PERFECTION

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 23, No 2, Feb 87  
(manuscript received 23 May 85) pp 284-287

[Article by V. V. Yeremkin, V. G. Smotrakov, Ye. S. Tsikhotskiy,  
V. A. Aleshin and Ye. G. Fesenko, Rostov State University imeni M. A. Suslov,  
Physics Scientific-Research Institute]

[Abstract] A method was proposed for growing  $\text{PbZr}_{1-x}\text{Ti}_x\text{O}_3$  (TsTS) crystals throughout the entire concentration range of  $x$  under conditions that would ensure minimal compositional imperfection. Using an established method, the material to be recrystallized was transferred in a solution-cum-melt of  $\text{PbO--B}_2\text{O}_3\text{--PbZr}_{1-x}\text{Ti}_x\text{O}_3$  from the bottom of a crucible to the crystallization zone by means of a vertical temperature gradient generated by a system of furnace heaters. The solvent consisted of a 1:15 weight ratio of  $\text{B}_2\text{O}_3$  and  $\text{PbO}$ . The temperature at the bottom of the crucible was 1240 to 1290 K, and the gradient was 10 to 20 K/cm. The experiment lasted from 75 to 100 hours. After crystallization had occurred, the crucible was removed from the furnace, and the solution/melt poured off, causing a sharp drop in temperature which led to the formation of a layer approximately 20  $\mu\text{m}$  thick on the surface of the developed faces of the crystals. This layer had a composition quite different than the rest of the crystal. The crystals obtained had a basically isometric shape with edges one to three mm in size. The composition, quality, and size of the crystals depended upon variations in charge composition, temperature, and preparation of the oxides being recrystallized. The specimens were ground and annealed in an atmosphere of  $\text{PbO}$  and 1070 K for 15 hours. Analysis on a Camebax-Micro x-ray microanalyzer revealed composition imperfection of approximately 0.015--0.025 for the value of  $\Delta x$ . The degree of structural perfection was studied on a DRON-0.5 x-ray diffractometer using the two-crystal spectrometer method. The crystal specimen and the crystal/monochromator were placed side-by-side in  $\text{CuK}_{\alpha 1}$ -radiation, monochromatized by reflections from quartz crystals. The reflection curves were recorded as the specimen turned around the main axis of the goniometer while the detector remained in a fixed position (method  $1\theta$ ) and during the synchronous revolution of the crystal at  $\Delta\theta$  and the detector at  $2\theta$  (method  $\theta/2\theta$ ). The experiment showed that the perfection of crystals grown in the manner described is completely determined by the conditions under which phase transitions occur within the crystals and that the structural perfection of  $\text{PbTiO}_3$ ,  $\text{PbZrO}_3$ , and  $\text{PbZr}_{1-x}\text{Ti}_x\text{O}_3$  crystals is determined by the same basic causes and mechanisms. References 8: 5 Russian, 3 Western.

13050/9835  
CSO: 1842/91

## THE MANUFACTURE AND PROPERTIES OF PKR-8 SEGNETO-RIGID PIEZOCERAMIC MATERIAL

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 23, No 2, Feb 87  
(manuscript received 23 Apr 85) pp 318-321

[Article by Ye. G. Fesenko, A. Ya. Dantsiger, O. N. Razumovskaya, R. U. Devlikanova, S. I. Dudkina, L. P. Moskaleva and Ye. S. Tsikhotskiy, Rostov State University imeni M. A. Suslov, Physics Scientific Research Institute]

[Abstract] Two different ways of making PKR-8 segneto-rigid piezoceramic material were studied to determine their effect on the material's properties. The PKR-8 was made either by hot pressing or by using conventional ceramic technology. The hot-pressed PKR-8 was made in the form of disks about 10 mm in diameter and one mm high or 110X110X25 mm<sup>3</sup> blocks. The conventionally-made material took the form of disks that were either about 10 mm in diameter by one mm high or about 30 mm in diameter by 10 mm. The material's properties were determined on specimens polarized with  $E=4$  MV/m at a temperature of 140°C for 20 minutes. The specimens were cooled at 90°C at a rate of two degrees/minute. Optimal properties in the hot-pressed material were obtained using PbCO<sub>3</sub>, especially pure TiO<sub>2</sub>, and ZrO<sub>2</sub> grade A Donets special material for the disks, and PbO and TiO<sub>2</sub> cond. for the blocks. The blocks and disks had essentially the same piezoelectric properties. An optimal conventional sintering technology was chosen on the basis of the relationship between the characteristics of the material and the specific pressure at which the blank was pressed, the temperature, and the holding time during sintering with and without a lead-bearing filler. Optimal characteristics were obtained with a specific pressing pressure of 196 MPa, sintering without leaded filler at 1230°C, and a holding time of one hour, and were slightly inferior to the properties of hot-pressed specimens. Conventionally-made PKR-8 compares favorably in its piezoelectric properties to hot-pressed TsTSS<sub>t-3</sub> and RZT-8 segneto-rigid materials. Its dielectric and mechanical losses were about two times lower than those of TsTSS<sub>t-3</sub>. Small adjustments in the raw-materials charges essentially eliminated the differences in the properties of hot-pressed and conventionally-made PKR-8. References 5: 2 Russian, 1 East German, 1 Western.

13050/9835

CSO: 1842/91

## DIELECTRIC LOSSES IN ELECTROCERAMICS AS A FUNCTION OF TEMPERATURE AND FREQUENCY

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 23, No 2, Feb 87  
(manuscript received 28 Jul 84) pp 322-326

[Article by Ye. G. Ashirov, O. G. Gorodetskaya, N. P. Grevtsova, N. N. Yermolenko, N. S. Kostyukov, M. I. Muminov, M. A. Mukhamedzhanov, V. N. Sandalov and Yu. S. Skripnikov, Nuclear Physics Institute, Uzbek Academy of Sciences]

[Abstract] Specimens of UF-46 and GB-7 electroceramics were studied to determine the extent to which dielectric losses and permittivity are dependent on temperature and frequency. The test frequencies were 0.3, 1.0, 3.0, 10, and 30 KHz, and the temperature range was 0 to 450°C. Between 100 and 400°C, dielectric losses sharply increased at all frequencies. Above 450°C, this dependence was less pronounced, especially at the lower frequencies. Permittivity also grew rapidly as the temperature increased at the lower frequencies; at the higher frequencies, permittivity growth was more moderate. A comparison of the values for full active electrical conductivity and for stationary electroconductivity revealed that the dielectric losses above 100°C were associated with thermal polarization processes. This is further corroborated by the pattern of permittivity growth. It was presumed that the thermal polarization processes were occasioned by weakly coupled alkaline ions in the vitreous phases of the electroceramic material. These ions can participate in both the migration and polarization processes. References 17: 13 Russian, 4 Western (2 in Russian translation).

13050/9835  
CSO: 1842/91

## LIQUID-PHASE SINTERING OF CERAMIC MATERIALS

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 23, No 2, Feb 87  
(manuscript received 24 Apr 85) pp 327-331

[Article by F. Ya. Kharitonov and Ye. Ya. Medvedovskiy, All-Union Scientific Research and Design-Technological Institute of Electroceramics]

[Abstract] Some aspects of the dissolution-precipitation phase that occurs during the liquid-phase sintering of ceramic materials was described and explained. The dissolution-precipitation process was conceptualized as a high-temperature electrochemical corrosion process. The liquid-phase sintering of corundum-mullite materials was used as an illustrative example. References 14: 12 Russian, 2 Western.

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## KINETICS OF NON-ISOTHERMAL LIQUID-PHASE SINTERING OF CERAMIC MATERIALS

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 23, No 2, Feb 87  
(manuscript received 24 Apr 85) pp 332-335

[Article by F. Ya. Kharitonov and Ye. Ya. Medvedovskiy, All-Union Scientific-Research and Design-Technological Institute of Electroceramics]

[Abstract] Some of the processes that take place during the dissolution-precipitation stage of the liquid-phase sintering of ceramic materials were represented mathematically. Mathematical expressions were constructed for the rate of solid-phase dissolution in the liquid phase, the rate of change in the diffusion (transition) layer over time, the thickness of the diffusion layer, a constant rate of temperature increase, the value for the diffusion coefficient, melt viscosity as a function of temperature, the dissolution process, and change in grain surface area as a function of temperature. The theoretical calculations show that the concentration of the solid phase in the melt is exponentially dependent on the process temperature, the condition of the original surface of the solid phase, the rate at which the temperature is increased, and the temperature at which the liquid phase appears. Liquid-phase sintering can therefore be regulated by controlling the temperature at which the liquid phase appears by using the right fluxes. The way in which the structure and composition of the liquid phase change also plays a role in the regulation of the sintering process. This theoretical framework was used as a basis for making a vacuum-tight, electrically insulating ceramic material distinguished by a relatively low sintering temperature, a wide sintered-state range, and excellent physical and engineering properties. One of the fluxes used was a component containing boron, which enabled the liquid phase to appear at a low temperature. References 9: 8 Russian, 1 Western (in Russian translation).

13050/9835  
CSO: 1842/91

## POLYCRYSTALLINE DIAMOND AGGREGATES OBTAINED BY THE USE OF HYDROCARBONS

Kiev SVERKHTVERDYIE MATERIALY in Russian No 2, Feb-Mar 87  
(manuscript received 12 Feb 86) pp 3-5

[Article by Ye. N. Yakovlev, O. A. Voronov and A. V. Rakhmanina, High Pressure Physics Institute, USSR Academy of Sciences]

[Abstract] Polycrystalline diamond aggregates were obtained without using metal catalysts in a carbon-hydrocarbon system. The specimens produced are light colored cylinders with dark edges, 10-50  $\mu\text{m}$  thick. The aggregates

consist of intergrown crystals with a morphology not significantly different from the morphology of crystals synthesized from hydrocarbons. A photograph of several specimens is presented. In combination with known data on the composition of natural diamonds, the results indicate quite probable the formation of natural Brazilian polycrystalline diamonds by decomposition of hydrocarbons at high pressures and temperatures.

References 16: 13 Russian, 3 Western.

6508/9835

CSO: 1842/155

UDC 548.33

#### FORMATION OF MICROSTRUCTURE OF POLYCRYSTALS DURING SINTERING OF CBN POWDERS

Kiev SVERKHTVERDYIE MATERIALY in Russian No 2, Feb-Mar 87 (manuscript received 25 Feb 86) pp 14-17

[Article by V. P. Kebko and N. P. Bezhenar, Superhard Materials Institute, Ukrainian Academy of Sciences]

[Abstract] A study was made of the evolution of the structure of cubic boron nitride under the influence of high pressure and temperature in the process of the production of polycrystals. Experiments were performed using an electron microscope to study microscopic KM 5/3 cubonite powder in the initial state and after exposure to 7.7 GPa, as well as CBN polycrystals sintered at the same pressure with heating currents of 2, 3 and 4 kW. The results indicated that as the polycrystal structure is formed, mechanical crushing of grains occurs, with intensive plastic deformation of grains, processes of fragmentation of the structure and recrystallization plus phase conversions. Structure formation of polycrystals based on CBN microscopic powders is primarily determined by the same processes as determine structure formation of materials obtained by sintering of Wurtzite boron nitride. References 6: all Russian.

6508/9835

CSO: 1842/155

## DETERMINATION OF ELECTROPHYSICAL PROPERTIES OF GRAPHITE

Kiev SVERKHTVERDYIE MATERIALY in Russian No 2, Feb-Mar 87  
(manuscript received 9 Jan 86) pp 17-19

[Article by A. L. Vetrov, Superhard Materials Institute, Ukrainian Academy of Sciences]

[Abstract] The purpose of this work was to develop a simple instrument system to allow measurement of the  $\rho$ ,  $T_{\min}$  and  $E$  of graphite rods. The essential element of the device created is a thermocouple of special design. The distinguishing feature of the device is that with the aid of a welding arc from one conductor one first forms a ball and then a second conductor is welded on next to the lead. The thermocouple is pressed against the specimen studied using the side of the ball opposite from the leads, allowing measurement at a single point on the specimen of both the temperature and thermal emf at the same time. The platinum conductor of the thermocouple and the cold end of the specimen studied are used to measure  $E$ .  
References 3: all Russian.

6508/9835

CSO: 1842/155

UDC 548.55

## PROPERTIES OF DOPED Si SINGLE CRYSTALS GROWN BY CZOCHRALSKI METHOD AND BY METHOD OF RIGIDLY MOUNTED COMMUNICATING VESSELS

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian Vol 23, No 3, Mar 87 (manuscript received 12 May 85) pp 357-360

[Article by M. Ya. Dashevskiy, V. V. Petrov and V. M. Mikhnenko, Moscow Steel and Alloys Institute]

[Abstract] Doping of Si single crystals during their growth by the method of rigidly mounted communicating vessels, two crucibles, is evaluated on the basis of technological design analysis of the apparatus and experimental data pertaining to the quality of the material thus produced. The determining factor is dependence of the dopant concentration in the melt on the critical geometrical ratio characterizing the two-crucible configuration, namely the area ratio of the two free melt surfaces. Among several possible variants of such an apparatus has been selected the one where two vertical coaxial cylindrical crucibles, one inside the other, communicate through a slot the very bottom of the inside wall. This configuration ensures constant areas of free melt surface, inner (circular) and outer (annular), therefore also their ratio throughout the process. Dislocationless Si single crystals were doped with phosphorus during growth in such an apparatus and in a one-crucible Czochralski apparatus for comparison. The results of calculations



and measurements indicate that phosphorus as well as optically active oxygen and microdefects are more uniformly distributed over the volume of crystals grown by the two-crucible communicating vessels method. Best results are obtained with a  $S_{\text{inner}}/S_{\text{outer}} = 0.84$  area ratio of the two free melt surfaces so that, with an effective dopant distribution coefficient  $k = 0.5$ , the dopant concentration in the outer crucible will remain zero and its distribution in the inner crucible will be perfectly uniform. References 8: 6 Russian, 2 Western.

2415/9835  
CSO: 1842/111

UDC 546.289

#### EFFECT OF HEAT TREATMENT ON PROPERTIES OF Ge DOPED WITH Cu

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian Vol 23, No 3, Mar 87 (manuscript received 16 May 85) pp 368-372

[Article by A. A. Gvelesiani, V. F. Degtyarev and Ye. V. Skudnova, Metallurgy Institute imeni A. A. Baykov, USSR Academy of Sciences]

[Abstract] An experimental study of Ge doped with Cu was made for the purpose of determining the dependence of its electrophysical properties on the heat treatment temperature. Specimens of Ge with an Sb concentration of approximately  $2 \cdot 10^{15} \text{ cm}^{-3}$  were doped with Cu to the saturation concentration of  $2 \cdot 10^{16} \text{ cm}^{-3}$  by the diffusion method at the 1120 K saturation temperature, whereupon the temperature was lowered to 1070 K and then in 40 K steps down to 870 K with a 4 h holding time at each level for attainment of a stable equilibrium state. Donor and acceptor concentrations were then determined separately from Hall coefficient and mobility measurements at temperatures of 4.2-300 K, after each heat treatment at a different temperature. Evaluation of the experimental data and qualitative theoretical analysis indicate that during breakup of Ge(Sb,Cu) solid solution at temperatures of 870-1070 K, with attendant movement of Cu atoms away from lattice nodes, the hole concentration decreases along with the acceptor concentration. Regulating the degree of compensation allows varying the donor:Cu concentration ratio. The temperature dependence of the Hall coefficient was found to be nonmonotonic and thus anomalous near the p-n transition upon lowering of the temperature, with the Hall mobility steeply dropping within the 300-77 K temperature interval, evidently owing to fluctuation of the space charge distribution in the presence of large defects rather than owing to peculiarities of charge carrier scattering by point defects. References 11: 9 Russian, 2 Western (1 in Russian translation).

2415/9835  
CSO: 1842/111

## ASTOICHIOMETRY OF CRYSTALLINE CdSe

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian  
Vol 23, No 3, Mar 87 (manuscript received 28 May 85) pp 394-398

[Article by Ya. L. Kharif, V. Yu. Brezhnev and P. V. Kovtunenkov, Moscow  
Chemical Technology Institute imeni D. I. Mendeleev]

[Abstract] Deviation of CdSe crystals from stoichiometric composition owing to dissolution of Cd in them is evaluated on the basis of theoretical analysis and an experiment. These yielded the dependence of the Cd concentration and of the attendant point defects in a CdSe crystal on the parameters of high-temperature synthesis and subsequent cooling for both CdSe single crystals and CdSe powder with a total impurity content below  $1 \cdot 10^{-3}$  wt.%. Elementary Cd for synthesis was extra pure and completely degassed. The concentrations of both Cd and Se were measured by the photocolometric method, using as indicators 4-(2-pyridyl diazo)-resorcin, a monosodium salt for  $\text{Cd}^{2+}$  ions, and orthophenylene diamine for  $\text{Se}^{4+}$  ions. Upon saturation exposure of CdSe crystals to Cd vapor at high temperatures, the solubility of Cd in CdSe was determined according to the Kukuk-Varema equation, assuming negligible Se solubility. Then Cd was extracted from the CdSe crystals by isothermal recrystallization at various temperatures covering the 770-1370 K range in a free volume with equilibrium between solid phase and vapor. Uniform distribution of fine donor centers over the crystal volume was monitored by measurement of electrical conductivity, free-electron concentration, and EPR spectrum before and after removal of successive layers by grinding, which revealed no changes in the case of a uniform distribution. References 13: 6 Russian, 7 Western (3 in Russian translation).

2415/9835

CSO: 1842/111

UDC 54-165

SOLID SOLUTIONS OF  $\text{PbTiO}_3$ -( $\text{Sr}_{0.5}\text{Bi}_{0.5}$ )( $\text{Mg}_{0.5}\text{Nb}_{0.5}$ ) $\text{O}_3$  SYSTEM

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian  
Vol 23, No 3, Mar 87 (manuscript received 12 May 85) pp 473-476

[Article by L. G. Kosyachenko, R. Z. Kleyne and Yu. N. Venevtsev,  
Physical Chemistry Scientific Research Institute imeni L. Ya. Karpov]

[Abstract] Solid solutions of the ceramic  $\text{PbTiO}_3$ -( $\text{Sr}_{0.5}\text{Bi}_{0.5}$ )( $\text{Mg}_{0.5}\text{Nb}_{0.5}$ ) $\text{O}_3$  system with both components having a perovskitic structure were synthesized experimentally,  $\text{PbTiO}_3$  being the known ferroelectric components with a high

Curie point at 490°C and  $(\text{Sr}_{0.5}\text{Bi}_{0.5})(\text{Mg}_{0.5}\text{Nb}_{0.5})\text{O}_3$  being a component with phase transition at a higher quasi-Curie point of 530°C. Specimens were produced by the conventional ceramics technology with two-stage annealing from at least analytically pure oxides and carbonates. Synthesis and first annealing at 1000°C for 1 h were followed by second annealing at a temperature not higher than 1200°C for 1 h at the highest temperature or longer at lower ones. Their microstructure was examined under a Tesla electron microscope. Their phase composition was determined and lattice parameters were measured in a URS-50TM x-ray diffractometer with  $\text{CuK}_\alpha$ -radiation source at room temperature. The temperature dependence of the dielectric permittivity and the loss tangent was determined in a Ye 8-2 bridge at a frequency of 1 kHz over the 150-650°C. The dielectric permittivity was found to peak nonmonotonically at a temperature consistently lower for solid solutions with higher  $(\text{Sr}_{0.5}\text{Bi}_{0.5})(\text{Mg}_{0.5}\text{Nb}_{0.5})\text{O}_3$  content. The lattice parameters at room temperature and the Curie point as well as the maximum dielectric permittivity and the corresponding temperature were found to depend on the  $(\text{Sr}_{0.5}\text{Bi}_{0.5})(\text{Mg}_{0.5}\text{Nb}_{0.5})\text{O}_3$  content, the lattice parameters as well as the maximum dielectric permittivity nonmonotonically. The lattice parameters, being largest in pure  $\text{PbTiO}_3$ , were found to peak again to successively somewhat smaller magnitudes for 20 mol.% and 35 mol.%  $(\text{Sr}_{0.5}\text{Bi}_{0.5})(\text{Mg}_{0.5}\text{Nb}_{0.5})\text{O}_3$ . Along with a corresponding trend of the maximum dielectric permittivity, this indicates strong piezoelectric characteristics of these two solid solutions confirmed by direct measurements. References 6: 5 Russian, 1 Western (in Russian translation).

2415/9835  
CSO: 1842/111

UDC 666.651

# WETTING OF ALUMINUM NITRIDE BY CERTAIN CALCIUM COMPOUNDS AND PRODUCTION OF A CERAMIC WITH ADDITIVES OF THE COMPOUNDS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 3, Mar 87 (manuscript received 7 Feb 86) pp 49-51

[Article by N. A. Gracheva, I. G. Kuznetsova, T. M. Sarkisyan and O. Ye. Surkova, Moscow Chemical Technology Institute]

[Abstract] A study was performed of the wetting of aluminum nitride to gain a more complete understanding of the processes occurring upon sintering of aluminum nitride in the presence of calcium silicate and borate as activating additives. Wetting was studied by the sessile drop method in a medium of helium on a substrate of high-density pyrolytic polished aluminum nitride. The work of adhesion was calculated. As temperature increased, the contact wetting angle decreased and the interaction energy increased. Melts of calcium silicate and borate and their mixtures with aluminum oxide wet aluminum nitride in the 1100-1600°C interval. The interaction energy of

over 10 kJ/mol indicates that a chemical interaction occurs. Use of calcium borate and silicate as activating additives during sintering of aluminum nitride produced a high-density ceramic with an open porosity of less than 1%. References 7: 6 Russian, 1 Western.

6508/9835  
CSO: 1842/124

UDC 666.798.2

# MICROMECHANICAL CHARACTERISTICS OF $Al_2O_3$ -TiN CERAMIC OBTAINED IN A HIGH PRESSURE CHAMBER

Kiev POROSHKOVAYA METALLURGIYA in Russian No 3, Mar 87 (manuscript received 13 Mar 86) pp 88-90

[Article by G. A. Barashkov, V. S. Neshpor, V. F. Berdikov, O. I. Pushkarev, Ye. A. Lavrenova and V. A. Pesin, Volga Branch, All-Union Scientific Research Institute of Abrasives and Grinding]

[Abstract] Micromechanical characteristics and fine structure parameters are used to estimate the degree of perfection of formation of cortinite nitride ceramic, obtained by hot pressing of finely dispersed titanium nitride and corundum powders, in a high pressure chamber under conditions of forced mass transfer as a function of the hot pressing time. The fine structure parameters were studied by x-ray and estimated on the basis of relative microdeformation and coherent scattering area of ceramic micro-particles or blocks. The corundum grains were found to be bonded by irregular-shaped titanium nitride inclusions located between them in tiny veins up to 2-3  $\mu m$  in diameter. Grain size in pure titanium nitride is 2-4  $\mu m$ . Many specimens of cortinite had cracks following hot pressing due to thermal stresses. Cortinite fractured primarily between crystals, pure titanium nitride having mixed intercrystalline transcrystalline fracture. References 3: all Russian.

6508/9835  
CSO: 1842/124

## PLAIN BEARINGS MADE OF SINTERED POROUS MATERIALS

Moscow STEKLO I KERAMIKA in Russian No 3, Mar 87 pp 8-9

[Article by I. I. Fuks, candidate of technical sciences, G. M. Bukolov, engineer, V. I. Volkov, engineer, and G. V. Nikitin, engineer, All-Union Scientific Research and Design-Technological Institute for Glass Machinery Building, Experimental Sanitation Engineering Products Plant]

[Abstract] Two sintered porous composite materials, ZhGrI.2D2.5K0.8 and ZhGrI.2K0.8 with 20% porosity, were tested for the dependence of their wear rate on the load pressure and the dependence of their load capacity on the sliding velocity. Experimental plain bearings of these materials were produced with a special tool made of WC8 tungsten carbide or "Elbor", cutting these materials at rates of 1.25-2.4 m/s (0.05-0.2 mm/rev) so as to remove 0.20-0.25 mm/pass. The bearings were tested in friction against a roller made of St45 carbon steel with a 45-48 Rockwell C hardness after heat treatment and with an  $R_a = 0.4-0.5 \mu\text{m}$  surface finish after machining. They were tested under load pressures of 0.3-2.5 MPa at a sliding velocity of 1 m/s, with the friction coefficient remaining within the 0.02-0.04 range. Similar bearings made of BrOSnZnSi5-5-5 bronze were tested analogously for reference in a comparative evaluation. Bearings made of the ZhGrI2D2.5K0.8 material, having the highest wear resistance of all three, were further tested at sliding velocities of 0.2-1.8 m/s, for a determination of their load capacity at each velocity in accordance with the p·v criterion. The results of these tests are useful for bearing design in terms of optimum length-to-diameter ratio  $l = (0.4-1.2)d$  on the basis of the allowable pressure·velocity product and temperature rise. References 5: all Russian.

J415/9835

CSO: 1842/97

## MONITORING NONHOMOGENEITY OF GLASS DURING PRODUCTION OF GLASS FIBER

Moscow STEKLO I KERAMIKA in Russian No 3, Mar 87 pp 11-13

[Article by V. I. Shelyubskiy, doctor of technical sciences, T. D. Zadorozhnaya, engineer, L. F. Yelchaninova, candidate of physico-mathematical sciences]

[Abstract] For quality control of glass balls and glass rods in the production of glass fiber, a method of monitoring the nonhomogeneity of glass has been developed by V. I. Shelyubskiy and tested in the United States at the Ferro Corporation laboratories. It is based on measurement of the mean refractive index and on its correlation with the high-temperature viscosity, the thus determined viscosity being much more sensitive to variations in the glass

composition than is the low-temperature viscosity measured directly with a viscometer. After eight years of experience, it was found to be necessary to further refine this method. This was done in a special study based on a statistical analysis of production samples taken over a period of 25-35 days in several USSR glass fiber manufacturing plants. The statistical characteristics of the nonhomogeneity index and the breakability index introduced for this purpose indicate that the method is indeed an adequate and effective one. References 6: 5 Russian, 1 Western.

2415/9835  
CSO: 1842/97

UDC 666.189.42-436

#### APPARATUS FOR PRODUCTION OF GLASS MICROBALLS

Moscow STEKLO I KERAMIKA in Russian No 3, Mar 87 pp 15-16

[Article by V. I. Blagov, engineer, V. I. Yekaterinchuk, engineer, and A. V. Benzen-Spiridonov, engineer, VNIIT]

[Abstract] A new apparatus has been developed for production of glass microballs, the advantages of microballs over powder including better fluidity as well as dimensional uniformity and less shrinkage. The apparatus consists of a vibratory hopper-batcher on top, a preheating chamber inside an electrical-resistance heater coil underneath, a fusing chamber inside an electrical-resistance heater coil below the latter, and a hermetic receptacle at the bottom. Both chambers are made of quartz glass and welded together so that the lower part of the preheating chamber dips into the fusing chamber below. In that dipping part of the preheating chamber two tuyeres holding an electrical-resistance heater coil and a throttle each have been cut. As clusters of glass pebbles of one size fraction are dropped down, draft produces an ascending counterflow of hot air or inert gas via the tuyeres. Softening of the clusters and formation of microballs are controlled by temperature, pressure, and flow regulation. Surface tension in the fusing chamber produces regular microballs of uniform size, which can be varied from several microns up. The apparatus produces glass microballs free of Na and K oxides, which degrade optical, mechanical, and electrical properties of glass, also free of Na and K salts which do so. At the same time, the process ensures no loss of valuable Na and K borates, which form protective films. Laminar flow precludes sticking of microballs to the inside walls before they fall into the metallic receptacle. References 4: 2 Russian, 1 East German, 1 Western.

2415/9835  
CSO: 1842/97

## DIES FOR DEPOSITION OF PROTECTIVE COATINGS ON FIBER OPTICS

Moscow STEKLO I KERAMIKA in Russian No 3, Mar 87 pp 16-17

[Article by V. V. Kashin, engineer, S. V. Kotov, engineer, S. Ya. Rusanov, engineer, and V. K. Sysoyev, candidate of physico-mathematical sciences, General Physics Institute, USSR Academy of Sciences]

[Abstract] A new die for deposition of protective coatings on fiber optics by extrusion has been developed which combines advantages of conventional plain glass dies and high-pressure dies. While a plain glass die is simple in construction and allows visual monitoring of the varnish or other polymer material during extrusion for concentricity control, a high-pressure die facilitates thickness control by pressure regulation. The die consists of a nozzle tapering to a narrow tip under a metallic container with fluid coating material. Excessive heating of the fluid, which causes its binding to the container wall, is prevented by water cooling through a jacket and contamination of the fluid during extrusion is prevented by a teflon cap. Varnish or other polymer flows down through a tube under gas pressure controlled by a manometer and a throttle, argon being used here. This prevents formation of a deep meniscus in the die and of air bubbles on the fiber surface, which would results in a discontinuous coating. The die was tested in an experimental deposition of a 60 m thick silicone coating on a 1000 m long optical fiber under a gage pressure of 10 kPa, the concentricity of the coating having been maintained within 6% throughout. References 5: 1 Russian, 4 Western.

2415/9835  
CSO: 1842/97

## CORDIERITE CERAMIC BASED ON LOW-GRADE CHRYSOTILE-ASBESTOS

Moscow STEKLO I KERAMIKA in Russian No 3, Mar 87 pp 21-23

[Article by Yu. I. Goncharov, doctor of technical sciences, and N. Ye. Sergeyev, engineer, Belgorod Technological Institute of Construction Materials imeni I. A. Grishmanov]

[Abstract] Cordierite materials are considered for thermal insulation and structural applications in the ceramics manufacturing industry, these materials not being refractory but having a sufficiently high deflection temperature of 1300°C. The feasibility of producing high-grade cordierite ceramic from low-grade chrysotile-asbestos was studied, using Bazhenovo asbestos and Prosyana kaolin. Grades-6,7 asbestos were each mixed with alumina, quartz sand, and 0-70% kaolin for producing cordierite of the

$2\text{MgO} \cdot 2\text{Al}_2\text{O}_3 \cdot 5\text{SiO}_2$  composition. Phase analysis in a DRON-3.0 x-ray diffractometer and differential thermal analysis have revealed that, without kaolin, cordierite begins to form at a temperature of  $1200^\circ\text{C}$  and its formation reaches peak intensity at  $1400^\circ\text{C}$  with grade-6 asbestos or at  $1300^\circ\text{C}$  with grade-7 asbestos. The melting point is  $40\text{--}50^\circ\text{C}$  lower with grade-7 asbestos than with grade-6 asbestos, but still remains above normal service temperature. Addition of kaolin lowers those critical cordierite formation temperatures. Two technologies have been developed on this basis which yield cordierite ceramic with better thermophysical and mechanical properties than conventional refractories. They are sintering of powder compacts with combustible additives such as petroleum coke or electrolytic tailings and casting without additives followed by drying and grinding. A material with respectively  $0.8 \text{ kg/m}^3$  or  $0.6\text{--}0.9 \text{ kg/m}^3$  density is thus obtainable. References 3: 2 Russian, 1 Western.

2415/9835

CSO: 1842/97

UDC 534.222.2

#### INFLUENCE OF SHOCK WAVE ENERGY AND SINTERING TEMPERATURE ON STRUCTURE AND PROPERTIES OF LEAD TITANATE-ZIRCONATE PIEZOCERAMIC

Moscow FIZIKA I KHIMIYA OBRABOTKI METALLOV in Russian No 2, Mar-Apr 87  
(manuscript received 24 Mar 86) pp 81-84

[Article by E. S. Atroshchenko, V. A. Gavrilin, A. M. Pastushkov, M. Ye. Prozorova and L. I. Mokiyevskiy, Penza]

[Abstract] A study is made of ceramic materials molded by shock waves. The influences of explosive energy and sintering temperature on the structure and properties of TsTS-19 ceramic were investigated. Microfractographic studies were performed on an electron microscope using carbon replicas of the fracture surface. It was found that alteration of explosive energy and sintering temperature can control the structure, phase composition and properties of the material. References 8: 7 Russian, 1 Western (in Russian translation).

6508/9835

CSO: 1842/144



## IMPACT TOUGHNESS OF REACTOR GRAPHITE

Moscow FIZIKA I KHIMIYA OBRABOTKI METALLOV in Russian No 2, Mar-Apr 87  
(manuscript received 17 Sep 86) pp 85-87

[Article by ZYu. S. Virgilyev and V. V. Gundorov, Moscow]

[Abstract] Experimental data are presented on the radiation change in impact toughness of reactor graphite bombarded at 340-360, 420-460 and 620-800 K over a broad interval of neutron fluences: from  $10^{19}$  to  $1.3 \cdot 10^{22}$  cm<sup>-2</sup> using specimens of prism shape measuring 5 x 5 x 10 mm. Bombardment at 340-360 K with over  $1 \cdot 10^{20}$  cm<sup>-2</sup> fluence resulted in rapid increase in impact toughness, which reached a maximum at about  $2 \cdot 10^{20}$  cm<sup>-2</sup> and then decreased. At 420-460 K over  $1 \cdot 10^{20}$  cm<sup>-2</sup>, impact toughness also increased, though more slowly, the maximum being reached at  $6-7 \cdot 10^{20}$  cm<sup>-2</sup>. Further increases in temperature caused still greater slowing in the rate of increase in impact toughness, decreasing the height of the maximum. Crack resistance, strength and modulus of elasticity were also increased under the same conditions. References 4: all Russian.

6508/9835

CSO: 1842/144

## BARIUM HEXAFERRITE PRODUCED FROM ELECTROPLATING TAILINGS

Moscow STEKLO I KERAMIKA in Russian No 4, Apr 87 pp 5-6

[Article by A. S. Vlasov, doctor of technical sciences, I. G. Stepanchikova, engineer, S. V. Makarov, engineer, V. A. Zaytsev, engineer, and A. S. Danilov, engineer, Moscow Chemical Technology Institute imeni D. I. Mendeleyev]

[Abstract] An experimental study has established the feasibility of producing  $\text{BaO} \cdot 6\text{Fe}_2\text{O}_3$  from electroplating tailings with a high  $\text{Fe}(\text{OH})_3$  content. Samples of such tailings from drain water in the Moscow Automatic Lines Plant were used for this purpose, the sludge containing 70.6%  $\text{Fe}(\text{OH})_3$  + 7.92%  $\text{Cr}(\text{OH})_3$  + 6.84%  $\text{Ca}(\text{OH})_2$  + 3.0%  $\text{Ni}(\text{OH})_2$  + 1.44%  $\text{Mg}(\text{OH})_2$  + 0.46%  $\text{Zn}(\text{OH})_2$  + 0.38%  $\text{Cu}(\text{OH})_2$  + 9.36% organic compounds. The technology was developed with the aid of differential thermal analysis, revealing an endothermic effect within the 400-430°C temperature range and thus indicating the expediency of pre-annealing the sludge at 400°C. This sludge was mixed with  $\text{BaCO}_3$  in various ratios with kaolin added after each ingredient had been pulverized to a specific surface area of 9000 cm<sup>2</sup>/g by the dry process in an electromagnetic grinding mill. Barium ferrites were thus obtained with the  $\text{Fe}_2\text{O}_3$ :BaO ratio varied from 3.0 to 6.0 in 0.5 steps. Specimens of each material were produced in a hydraulic press with 10% solution of polyvinyl chloride serving as

lubricant. According to mechanical tests performed on 8 mm thick bar specimens 10 mm wide and 25 mm long,  $\text{BaO} \cdot 6\text{Fe}_2\text{O}_3$  has the highest compressive and flexural strength but also the lowest wear resistance,  $\text{BaO} \cdot 4.5\text{Fe}_2\text{O}_3$  having the highest wear resistance. According to magnetic tests performed on ring specimens 30 mm in diameter, stoichiometric  $\text{BaO} \cdot 6\text{Fe}_2\text{O}_3$  has the highest coercive force and the latter dips to a minimum for  $\text{BaO} \cdot 4.5\text{Fe}_2\text{O}_3$  before it increases again as the  $\text{Fe}_2\text{O}_3$ :BaO ratio decreases further. The phase composition of specimens, after annealing at a temperature of 1200°C for 5 min, was determined in a DRON-3 x-ray diffractometer with  $\text{CuK}_\alpha$ -radiation source and with the aid of ASTM identifier data. Accordingly, this  $\text{BaO} \cdot 6\text{Fe}_2\text{O}_3$  crystallizes into 4-5  $\mu\text{m}$  thick and 10-18  $\mu\text{m}$  long needles surrounded by a glassy phase and accompanied by small amounts of fine-grain other ferrites ( $\text{NiFe}_2\text{O}_4$ ,  $\text{ZnFe}_2\text{O}_4$ ,  $\text{CaFe}_4\text{O}_7$ ). References 4: 3 Russian, 1 Western.

2415/9835

CSO: 1842/134

UDC 666.189.2

#### OPTIMIZATION OF GLASS-FIBER DRYING PROCESS

Moscow STEKLO I KERAMIKA in Russian No 4, Apr 87 p 10

[Article by V. G. Velikodnyy, engineer, V. A. Rychko, candidate of technical sciences, and T. M. Bachilo, engineer, All-Union Scientific Research Institute of Glass-Plastics and Glass Fiber, Ukrainian Branch]

[Abstract] For production of glass-reinforced composite materials, the glass fibers are protectively coated with a plain grease or paraffin emulsion containing 88-94% water. The moisture content may still be as high as 15% during extrusion and must be reduced to below 0.5% for further processing. An experimental study involving differential thermal analysis as well as thermogravimetry and differential thermogravimetry with an MOM derivatograph and with  $\text{Al}_2\text{O}_3$  as inert medium, specimens of coated fibers being heated at a rate of 10°C/min, has yielded data necessary for optimization of the drying process. No change in any of the various lubricants was found to occur upon heating up to 120-130°C, except for slight endothermic dips characterizing removal of residual moisture. Within the 120-200°C temperature range, however, an exothermic effect indicated destruction of the lubricant beginning at a different temperature within a narrow or up to 20°C wide interval for each of the various lubricants. The optimum drying temperature must, therefore, be below that interval, which for paraffin emulsion, the most stable of them, is 130-140°C. Drying at such a temperature for 5-6 h will not destroy the lubricant as long as it still contains 0.1% moisture. At the optimum temperature, moreover, the drying period can be shortened to 4-4.5 h. References 4: all Russian.

2415/9835

CSO: 1842/134

## QUASI-ISOSTATIC PRESSING OF SAGGERS

Moscow STEKLO I KERAMIKA in Russian No 4, Apr 87 pp 15-16

[Article by M. I. Timokhova, candidate of technical sciences, R. V. Dzerzhinskiy, engineer, V. A. Makarov, engineer, and V. S. Rachkov, engineer, All-Union Scientific Research and Design-Technological Institute of Electroceramics]

[Abstract] A method of isostatic triaxial pressing has been invented (USSR patent disclosure No 916,310), the simplest so far, for production of sagggers and other ceramic parts with uniform density and homogeneous structure throughout the volume. The mold for this quasi-isostatic pressing consists of a floating metal die on spring mounts, designed to allow bilateral transverse compression during plunger action, a short plunger-cap pressing vertically down, and a knock-out pin ejecting the pressed part upward from below. The mold does not require costly isostatic controls. Its other advantages over isostatic ones are a smaller height and less wear. The productivity is the same, but so far only small clay or fireclay sagggers can be produced. Further development is underway aimed at production of larger sagggers, up to 330 mm in diameter, by quasi-isostatic pressing. Specimens have been tested in porcelain kilns with excellent results. References 5: all Russian.

2415/9835

CSO: 1842/134

UDC 666.762

## GLASS-CERAMIC MATERIALS WITH HIGH HEAT RESISTANCE

Moscow STEKLO I KERAMIKA in Russian No 4, Apr 87 pp 16-17

[Article by N. M. Bobkova, doctor of technical sciences, L. M. Silich, candidate of technical sciences, Ye. M. Kurpan, candidate of technical sciences, and S. A. Gaylevich, candidate of technical sciences, Belorussian Technological Institute]

[Abstract] Materials with high heat resistance now available include composite ones, most effective being those which consist of a glass matrix and a ceramic filler. A crystalline filler with uniquely excellent thermophysical properties, including a high melting point and a negative temperature coefficient of linear thermal expansion, is  $\text{Al}_2\text{TiO}_5$  (tialite). It can be used alone or with  $\text{SrAl}_2\text{Si}_2\text{O}_8$  (anortite). Analogous filler materials are  $\text{BaAl}_2\text{Si}_2\text{O}_8$  ( $\beta$ -celsian) and two Mg-Al titanates  $\text{Mg}_3\text{Al}_4\text{Ti}_3\text{O}_{25}$ ,  $\text{Mg}_4\text{Al}_2\text{Ti}_9\text{O}_{25}$ . These filler materials have been tested not only for deflection temperatures under no load and under a pressure of 1 MPa but also for fatigue resistance under 20-1000-20°C temperature cycles of 1 min duration, temperature coefficient

of linear thermal expansion over the 100-400°C range, apparent density, compressive strength, electrical volume resistivity, dielectric permittivity and loss tangent, and water absorption. The deflection temperatures increase slightly and the temperature coefficient of thermal expansion decreases sharply as the  $\text{Al}_2\text{TiO}_5$  content in the filler mixture is increased above 50%. References 5: 3 Russian, 2 Western (1 in Russian translation).

2415/9835

CSO: 1842/134

UDC 546.3-631'881'281'289

#### INTERACTION OF SCANDIUM WITH VANADIUM AND SILICON (OR GERMANIUM)

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 23, No 4, Apr 87  
(manuscript received 18 Jun 85) pp 558-561

[Article by B. Ya. Kotur, Lvov State University imeni I. Franko]

[Abstract] A study is made of the state diagrams of several binary systems within the system Sc-V-Si (Ge) prepared in an electric-arc furnace by melting high purity components in purified argon. Phase equilibria in the ternary system with silicon were studied on the basis of 10 binary and 68 ternary alloys. Isothermic cross sections of the constitution diagram were constructed at 1070 K. 13 binary and 72 ternary alloys were studied in the system with germanium. Three ternary compounds were found in the system with silicon:  $\text{ScV}_5\text{Si}_5$ ,  $\text{Sc}_2\text{V}_3\text{Si}_4$  and  $\text{Sc}_2\text{V}_3\text{Si}_3$ . In the system with germanium, two ternary compounds were found:  $\text{Sc}_x\text{V}_{6-x}\text{Ge}_5 (1 \leq x \leq 1.8)$  and  $\text{Sc}_2\text{V}_3\text{Ge}_4$ . The crystalline structure of these compounds was established. Scandium was found to differ from rare earth metals in its interaction with vanadium and silicon or germanium, acting as a typical transition metal. References 16: 12 Russian, 4 Western (1 in Russian translation).

6508/9835

CSO: 1842/143

STUDY OF SINGLE CRYSTALS OF TITANIUM DIOXIDE OBTAINED BY CRYSTALLIZATION OF A MELT IN A COLD CRUCIBLE

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 23, No 4, Apr 87  
(manuscript received 18 Jun 85) pp 587-589

[Article by V. D. Tkachenko and A. A. Dvernyakova, General and Inorganic Chemistry Institute, Ukrainian Academy of Sciences]

[Abstract] Results are presented from studies of the production of titanium dioxide single crystals by high frequency induction heating. The crystals were grown using rutile obtained by thermal hydrolysis of titanium chloride from a hydrochloric acid solution. Single crystals were grown by directed crystallization of the melt, moving the crucible containing the melt with respect to the inductor. The rutile single crystals produced had basically block structure, were black in color and became transparent after annealing. The large crystals were quite chemically pure and some had perfect faces. The activation energy of conductivity in the single crystals was 1.7 and 0.8 eV for the low- and high-temperature areas. References 6: all Russian.

6508/9835

CSO: 1842/143

CONDUCTIVITY OF SOLID SOLUTIONS BASED ON ZIRCONIUM DIOXIDE

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 23, No 4, Apr 87  
(manuscript received 24 Jun 85) pp 590-593

[Article by T. V. Chusovitina and Yu. S. Toropov, Eastern Scientific Research and Planning Institute of the Refractory Industry]

[Abstract] A study is made of the conductivity of solid solutions of zirconium dioxide with the oxides of yttrium, ytterbium, scandium and calcium at 500-1450°C using powders prepared by joint precipitation of the components from solutions of their chlorides by an ammonia solution. The dried hydroxides were dispersed, redried and calcined at 100°C. The powders produced were used to mold specimens measuring 5 x 5 x 35 mm<sup>3</sup> at 150 MPa which were then heated at 1700°C. Resistivity was measured by a two-contact method with an ac bridge at 3 KHz in the process of cooling of the specimens. The activation energy of conductivity of the solid solutions was found to be influenced by temperature. There are extremes on the curves illustrating concentration dependence of conductivity and its activation energy, particularly clearly expressed in the high temperature area. These peculiarities result from the interaction of oxygen vacancies and cations of the stabilizing oxide with the formation of associates. The degree of association depends on temperature,

concentration and form of stabilizing additives. In the low temperature area, solid electrolytes containing a stabilizing additive close to the lower boundary of the existence of the fluorite phase should be used. References 8: 6 Russian, 2 Western (1 in Russian translation).

6508/9835

CSO: 1842/143

UDC 539.213:537.311.33

# MAGNETIC SUSCEPTIBILITY AND STRUCTURAL-CHEMICAL SPECIFICS OF GLASSES IN THE SYSTEM As-S-I

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 23, No 4, Apr 87  
(manuscript received 12 Jun 85) pp 654-657

[Article by V. P. Pinzenik, A. N. Kramarenko, V. V. Khiminets and I. I. Rosola, Uzhgorod State University]

[Abstract] Glasses in the system  $As_2S_3$ - $AsI_3$ , with high values of photo-elastic constants, were selected for analysis. The glasses were synthesized from elementary substances of semiconductor purity, placed in quartz ampules and evacuated to 0.1 Pa, then held at 1070-1100 K for 24 hours, and cooled in air. With small concentrations of impurities, depending on impurity atom type, there is an extreme on the curve of magnetic susceptibility as a function of concentration. The structure of glasses in this area of composition reflects the peculiarities of the structure of a stable eutectic. The variation of magnetic susceptibility with concentration agrees with the model of microheterogeneous structure of the glasses. Slight additives of elements differing in their electron structure, such as iodine and iron, lead to various peculiarities in the curves of magnetic susceptibility as a function of concentration. References 14: 13 Russian, 1 Western.

6508/9835

CSO: 1842/143

UDC 661.664.3:620.193.22

# OXIDATION OF HOT PRESSED BORON CARBIDE

Kiev POROSHKOVAYA METALLURGIYA in Russian No 4, Apr 87 (manuscript received 1 Apr 86) pp 56-60

[Article by L. N. Yefimenko, Ye. V. Lifshits, I. T. Ostapenko, I. A. Snezhko and E. P. Shevyakova, Kharkov Physical Technical Institute]

[Abstract] A study is presented of oxidation in air of hot pressed boron carbide of stoichiometric composition with mass content of impurities of not

over 0.25% under isothermal conditions at up to 1200 K, and also of the influence of porosity on oxidation rate. Oxidation at 800-1200 K followed a near parabolic curve. The activation energy of the oxidation process was found to be 108 kJ/mol. X-ray structural and crystal-optical analysis and IR spectroscopy indicated the formation of  $B_2O_3$  upon oxidation which, when held in air, produced the hydrated forms  $HBO_2$  and  $H_3BO_3$ . References 15: 11 Russian, 4 Western (1 in Russian translation).

6508/9835

CSO: 1842/157

UDC 536.63:546.181.1

#### HEAT CAPACITY OF CADMIUM DIPHOSPHIDE AT 6-400 K

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 23, No 5, May 87  
(manuscript received 29 Jul 85) pp 714-716

[Article by A. U. Sheleg, N. P. Tekhanovich and T. I. Yakubenko, Solid State and Semiconductor Physics Institute, Belorussian Academy of Sciences]

[Abstract] Measurements are presented of the heat capacity of tetragonal cadmium diphosphide at 6-400 K, performed on single crystal specimens in a vacuum adiabatic calorimeter using liquid helium and nitrogen as the cryogenic fluid. A sequence of phase transitions was observed, related to the existence of modulated structures representing comparable and non-comparable states. References 7: 5 Russian, 2 Western.

6508/9835

CSO: 1842/156

UDC 546.681.19,817.221:542.943

#### OXIDATION OF GaAs WITH PbS LAYER ON ITS SURFACE

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 23, No 5, May 87  
(manuscript received 22 May 85) pp 717-720

[Article by I. Ya. Mittova, V. V. Pukhova, V. N. Semenov and Zh. A. Verevkina, Voronezh State University]

[Abstract] A study is presented of the chemistry of oxidation of GaAs coated with a layer of PbS. The study was performed on type AGP-1 and SAGOCh-1 GaAs with orientation (100) and resistivity  $10^8$ - $10^9$  and 0.01-0.018 Ohm·cm, respectively. The GaAs plates were held in concentrated HF for 20 minutes and then in chromic acid mixture until the surface was completely wet. They were then placed in a precipitation bath containing a dissolved salt of lead ( $Pb(CH_3COO)_2 \cdot 3H_2O$ ) with thiourea ( $N_2H_4CS$ ) as sulfidizer and

KOH to maintain pH for 25-30 minutes. The oxide layers formed were analyzed by mass spectrometry using a laser ion source, x-ray spectral analysis and IR spectrometry. Oxidation first involves formation of  $\text{PbSO}_4$ , followed by  $\text{PbO}$  which may be oxidized by the gallium of the substrate. The rate of formation of oxide layers upon thermal oxidation of GaAs-PbS structures and their dielectric strength are both higher than for GaAs. References 13: 10 Russian, 3 Western (1 in Russian translation).

6508/9835  
CSO: 1842/156

UDC 543.423

#### ELECTRON STRUCTURE OF $\text{GeAs}_2$

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 23, No 5, May 87  
(manuscript received 11 Jul 85) pp 721-726

[Article by Ya. A. Ugay, Ye. M. Averbakh, A. S. Skuratov and V. M. Kashkarov, Voronezh State University]

[Abstract] The calculation procedure of crystalline orbitals as a linear combination of atomic orbitals in the strong bond version was used to perform a semiempirical computation of the energy spectrum of valence electrons of a germanium diarsenide crystal in the nearest neighbor approximation, such that the interaction radius did not exceed 0.320 nm. The 4s-4p electrons of the germanium and arsenic atoms participate in the formation of the chemical bond in  $\text{GeAs}_2$ . The calculation method used yields fully satisfactory agreement between calculated electron spectrum and the x-ray emission spectrum of the arsenic and  $\text{GeAs}_2$ . The crystalline structure of  $\text{GeAs}_2$  has continuous cavity channels along the c axis with transverse dimensions sufficient to permit insertion of impurity atoms. References 14: 10 Russian, 4 Western. (1 in Russian translation).

6508/9835  
CSO: 1842/156



INFLUENCE OF HEAT TREATMENT ON ELECTROPHYSICAL PROPERTIES OF  $\text{GeAs}_2$ 

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 23, No 5, May 87  
(manuscript received 4 Jul 85) pp 727-729

[Article by Ya. A. Ugay, A. Ye. Popov, Ye. G. Goncharov, S. P. Yevseyeva and S. A. Turkin, Voronezh State University]

[Abstract] A study is presented of the electrophysical properties of germanium diarsenide as a function of temperature and pressure of the volatile component in the process of manufacture and heat treatment. The variation of electrophysical properties as functions of saturated arsenic vapor pressure was constructed, establishing the influence of pressure on concentration of charge carriers within the limits of the area of homogeneity of germanium diarsenide. Studies were performed on  $\text{GeAs}_2$  single crystals obtained by directed crystallization with controlled arsenic vapor pressure of 2500-4500 GPa using polycrystalline germanium purified by zone melting. Depending on synthesis and heat treatment conditions, both n- and p-germanium diarsenide crystals were produced. Electron conductivity was observed only in crystals grown by directed crystallization at arsenic vapor pressures of 4200-4500 GPa. Annealing at temperatures lower than the eutectic point produced only p-type specimens. References 7: 5 Russian, 2 Western.

6508/9835  
CSO: 1842/156

ANISOTROPY OF THERMAL EXPANSION OF  $\text{AgGaSe}_2$  IN THE 80-650 K INTERVAL BASED ON X-RAY DATA

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 23, No 5, May 87  
(manuscript received 9 Jul 85) pp 758-761

[Article by I. V. Bodnar and N. S. Orlova, Solid State and Semiconductor Physics Institute, Belorussian Academy of Sciences]

[Abstract] The anisotropy of thermal expansion of compounds of the type  $\text{A}^{\text{I}}\text{B}^{\text{III}}\text{C}^{\text{VI}}_2$  containing silver is studied by x-ray determination of the temperature variation of unit cell parameters and the main coefficients of thermal expansion of  $\text{AgGaSe}_2$  in the 80-650 K temperature interval. Measurements were performed on powder specimens prepared from single crystals grown by the Bridgman method. The measured values of the diffraction angle were used to determine the plane separation, which in turn was used to calculate the unit cell parameters by the method of least squares. In the 80-650 K temperature interval, the coefficients of thermal expansion of  $\text{AgGaSe}_2$  along the tetragonal axis and along the more covalent bond between Ga and Se atoms

are negative, while in the direction perpendicular to the major axis and along the more ionic bond between the Ag and Se atoms they are positive. Both of the main thermal expansion coefficients increase with increasing temperature, particularly in the 80-300 K interval, and the anisotropy of thermal expansion also increases. References 12: 1 Russian, 11 Western.

6508/9835

CSO: 1842/156

UDC 546.34:546.311

#### DISTRIBUTION OF ALKALI METALS IN SUPERSONIC LITHIUM VAPOR JET

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 23, No 5, May 87  
(manuscript received 17 Jul 85) pp 785-787

[Article by V. A. Dyachkov, V. I. Zinenko and A. D. Styrkas, Solid State Physics Institute, USSR Academy of Sciences]

[Abstract] The distribution of concentration of sodium, potassium and rubidium over the central area of the plane of a supersonic lithium vapor jet was measured, using a model of a neutralizer for the hydrogen neutral injector used in thermonuclear installations, not specially designed for investigation of separation processes. Heavy metal impurities were found to be segregated and accumulated at the center of the jet. The method of gas dynamic jet separation can be used for purification of lithium. References 15: 9 Russian, 6 Western (1 in Russian translation).

6508/9835

CSO: 1842/156

UDC 546.763'492'231:669.018.5

#### PRODUCTION OF $\text{HgCr}_2\text{Se}_4$ BY HOT PRESSING AND ITS PROPERTIES

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 23, No 5, May 87  
(manuscript received 16 Jul 85) pp 860-861

[Article by E. G. Zhukov, V. A. Levshin, Ye. S. Polulyak, I. Kurbanklychev, V. A. Davydov and V. A. Fedorov, General and Inorganic Chemistry Institute imeni N. S. Kurnakov, USSR Academy of Sciences; High Pressure Physics Institute imeni L. F. Vereshchagin, USSR Academy of Sciences]

[Abstract] The purpose of this work was to produce compact pressed specimens of  $\text{HgCr}_2\text{Se}_4$  at high temperatures and pressures and to study their properties. Initial materials used were polycrystalline powders synthesized from mercury, chromium and selenium in stoichiometric quantities. The pressed specimens

were used to study the temperature variation of conductivity, Hall coefficient, thermal emf, and Hall mobility of charge carriers in the 300-670 K interval. Highly compact pressed specimens of stoichiometric composition were found to have been produced, with electrophysical properties similar to those of single crystals. References 6: 2 Russian, 1 Polish, 3 Western.

6508/9835

CSO: 1842/156

UDC 666.65

#### SYNTHESIS OF PIEZOCERAMICS IN A HIGH FREQUENCY ELECTRIC FIELD

Moscow STEKLO I KERAMIKA in Russian No 5, May 87 pp 20-21

[Article by G. I. Berdov, doctor of technical sciences, S. A. Polev, candidate of technical sciences, N. I. Tyuleneva, candidate of chemical sciences, and Z. S. Shustova, engineer, Novosibirsk Construction Engineering Institute]

[Abstract] A study was made of the synthesis of solid solutions of lead zirconate-titanate from oxides in a high frequency electric field and by ordinary thermal synthesis. The oxides were mixed in the stoichiometric ratio, ground in a ball mill and pressed in tablets. The specimens were then placed in a furnace and exposed to the electric field produced by a 70 W generator at 40.68 MHz. The electric field was found to facilitate intensification of synthesis of the piezoceramic, having a unique catalytic effect on the solid phase reaction and significantly decreasing the temperature required for the interaction, the activation energy of the reaction and its time. References 4: all Russian.

6508/9835

CSO: 1842/154

UDC 666.65

#### METHODS OF REVEALING DEFECTS IN SODIUM POLYALUMINATE-BASED CERAMICS

Moscow STEKLO I KERAMIKA in Russian No 5, May 87 pp 22-23

[Article by I. A. Alimova, candidate of physical and mathematical sciences, L. A. Lyutsareva, candidate of technical sciences, Ye. D. Pivnik and N. A. Yakovleva, engineers, VNIIT [expansion uncertain]]

[Abstract] The physical and chemical properties of sodium polyaluminate-based ceramic are determined. The method used to determine density was developed for measurement of the apparent density of porous bodies based on

a known precision flotation method of density measurement. Closed porosity was determined by measuring the density of specimens, subsequent grinding of the specimens and measurement of the density of the powder. The methods were used to detect and investigate local heterogeneities in apparent density, the distribution of lithium additive, loss of lithium in the technological process and closed porosity. References 3: all Russian.

6508/9835  
CSO: 1842/154

UDC 666.762.852

#### SILICON CARBIDE ELECTRIC HEATERS IN CERAMIC AND GLASS INDUSTRY FURNACES

Moscow STEKLO I KERAMIKA in Russian No 5, May 87 pp 23-24

[Article by V. K. Zakharenkov, candidate of technical sciences, L. G. Gurvich, A. V. Kartunen and N. I. Gerasimovich, engineers, State Scientific Research Institute of Stone and Silicates; All-Union Refractories Institute]

[Abstract] Operating conditions and service life of silicon carbide electric heaters used in ceramic and glass industry furnaces are investigated. Studies are based on data from 121 enterprises with a total of 2700 electric furnaces utilizing 6,700 heating elements. As the roasting temperature increases from 900 to 1460-1520°C, the mean service life of heating elements decreases from 2550 to 1610 hours. Continuous operation yields the longest life; operation with the furnace turned off two days each week greatly reduces service life, from 2187 to 1254 hours. Use of pure oxygen or a vacuum reduces service life to 926-1110 hours in comparison to air. Aging of heaters, with accompanying increase in resistance, burnout and damage to leads are the most important reasons for failure of heating elements. Replacement of type A, V and BS heaters with improved BP and B heaters is recommended. References 6: 3 Russian, 3 Western.

6508/9835  
CSO: 1842/154

UDC 666.85/89

#### PROGRESSIVE TECHNOLOGY FOR PRODUCTION OF CAST STONE TILE PRODUCTS

Moscow STEKLO I KERAMIKA in Russian No 5, May 87 pp 25-26

[Article by I. I. Bykov, candidate of technical sciences, L. F. Lekarenko, engineer, Casting Problems Institute, Ukrainian Academy of Sciences; Donetsk Cast Stone and Ceramic Products Plant]

[Abstract] A mechanized line for production of 180 x 115 x 18 mm cast stone lining tiles installed at the Donetsk Cast Stone and Ceramics Products Plant

in 1977 has not been satisfying the requirements of consumers, that tile thicknesses were not uniform, adhesion to surfaces and materials was poor and thermal stability was unsatisfactory. The line was improved by the use of single-layer heat treatment in a furnace with a roller conveyor, rather than heat treatment of tiles in a large furnace on trucks carrying many layers of tile. Temperature and time parameters were determined which produced a hard crust of the required thickness on the tiles: Melt pouring temperature, 1473-1503 K; mold temperature, 523-573 K; pouring time, 1.5-2 sec; time span to pressing of casting, 15-20 sec; time span of pressing at 2.0-2.5 MPa, 10-12 sec; holding of product in mold, 50 sec; holding of tile in soaking furnace, 12-16 sec; temperature in soaking furnace, 673-723 K. The modified mechanized line now includes a pouring machine, 40-position carousel molding unit, transfer mechanism and soaking furnace, and crystallization-roasting furnace roller conveyor. References 3: all Russian.

6508/9835

CSO: 1842/154

UDC 666.193

#### CONTINUOUS BASALT FIBER

Moscow STEKLO I KERAMIKA in Russian No 5, May 87 pp 30-31

[Article by L. A. Lyuchev, candidate of technical sciences, G. G. Gogova and D. T. Gogov, engineers, Higher Chemical-Technological Institute (Bulgaria)]

[Abstract] The purpose of this work was to synthesize a continuous glass fiber with good mechanical and chemical properties from basalt. The basic raw material used was basalt flour obtained by crushing of basalt and factory-reject basalt pipe. The conditions for the melting and crystallization of basalt compositions with and without boron oxide, their behavior during melting and the crystallization capacity of certain glasses obtained in a reduced medium were determined. The basalt fibers produced had good hydrolytic quality (class I). Acid resistance of most compositions was low. A leaching process was observed, producing fibers with high content of silicon dioxide. The synthesized glasses are suitable for drawing of continuous basalt fibers with good chemical stability and mechanical strength. References 3: all Russian.

6508/9835

CSO: 1842/154

PREPARATION

UDC 669.27:541.18.053

INFLUENCE OF PROCESSING IN AN ATTRITION MILL ON THE STRUCTURE AND PROPERTIES OF TUNGSTEN POWDERS AND ITS MIXTURES WITH RHENIUM POWDER

Moscow FIZIKA I KHIMIYA OBRABOTKI METALLOV in Russian No 2, Mar-Apr 87  
(manuscript received 21 Aug 86) pp 118-122

[Article by K. B. Povarova, P. V. Makarov, Ye. K. Zavarzina, A. A. Kolesnikov, A. B. Olshanskiy, V. A. Korol and V. I. Gachegov, Moscow]

[Abstract] A study is made of the influence of high energy mixing in an attrition mill on the nature of the change in structure of tungsten powder and the distribution of the alloying element rhenium in the tungsten. The change in shape and sizes of the powders after 1, 10 and 40 hours of processing were determined and are illustrated with photographs. The tungsten powder particles were flattened and broken but did not aggregate or form bent flakes as have been observed in particles with space-centered cubic crystalline structure. Treatment of tungsten with 5% rhenium was found to yield a quasihomogeneous distribution of the rhenium in the tungsten powder. References 4: 1 Russian, 3 Western.

6508/9835

CSO: 1842/144

UDC 669.26-122:548.735.6

INFLUENCE OF ANNEALING ON STRUCTURE, COLD SHORTNESS AND MECHANICAL PROPERTIES OF TUNGSTEN WITH CARBIDE HARDENING

Moscow METALLY in Russian No 2, Mar-Apr 87 (manuscript received 8 Oct 85)  
pp 97-101

[Article by L. S. Kosachev, Yu. V. Milman, V. F. Pushkin, G. A. Rymashevskiy and G. Ye. Khomenko, Kiev]

[Abstract] Ingots of W-Zr-C alloy were obtained by vacuum arc melting. The chemical composition was Zr, 0.2; C, 0.02; N, 0.0003-0.0008; O<sub>2</sub>, 0.003-0.008 mass percent. Twelve mm diameter bars were produced by double pressing to

study the structure and mechanical properties after various types of intermediate annealing and at various second pressing temperatures. Both unalloyed tungsten and the dispersion-hardened alloy show similar changes in upper and lower cold shortness temperatures as functions of annealing temperature, varying with effective grain size. Variations from straight dependence on grain size result from aging and changes in microdistortions of the crystalline lattice; aging influences the upper and lower cold shortness temperatures, while microdistortions influence only the upper temperature. The combined influence of the factors determines the temperature range of cold shortness and its variation with deformation and annealing conditions. Partial recrystallization annealing in the homologous recrystallization temperature range is optimal from the standpoint of low temperature ductility, regardless of chemical composition and previous treatment. References 14: 13 Russian, 1 Western.

6508/9835  
CSO: 1842/131

UDC 669.295:621.787.044

#### INFLUENCE OF LASER CHEMICAL-THERMAL TREATMENT ON STRUCTURE AND PROPERTIES OF TITANIUM AND ITS ALLOYS

Moscow METALLY in Russian No 3, May-Jun 87 (manuscript received 9 Dec 85)  
pp 161-166

[Article by Yu. M. Lakhtin, Ya. D. Kogan, D. P. Shashkov, L. A. Teplova and N. S. Yudina, Moscow]

[Abstract] A study of the formation of a hardened layer upon laser alloying was performed on specimens made of technically pure titanium type VT1-0, the pseudo- $\alpha$ -alloys AT-3 and AT-6 and the ( $\alpha + \beta$ )-alloy VT-22. The maximum effect of increased hardness with preservation of sufficient ductility was observed by laser alloying using coatings containing boron and silicon carbides. Laser chemical-thermal treatment without the use of a telescopic system helps to form a hardened layer of less thickness but higher microhardness by increasing the saturation density of the melted volume. The optimal increase in microhardness with preservation of sufficient ductility is 25,000 MPa on titanium, 19,000 on AT-6 and 16,800 on VT-22. The treatment increases heat strength at 500°C in all alloys by the formation of a complexly alloyed  $\alpha'$ -solid solution hardened with borides. Carbosiliciding produces a greater decrease in creep rate by forming a reticular framework of titanium silicides. Corrosion resistance of the laser hardened alloys in 40% H<sub>2</sub>SO<sub>4</sub> is increased, and is determined by the continuity of the intermetallide surface layer. Corrosion resistance in 20% solutions of HNO<sub>3</sub>, HCl and H<sub>3</sub>PO<sub>4</sub> decreases. References 8: 6 Russian, 2 Western.

6508/9835  
CSO: 1842/163

UDC 621

## DIAMOND TOOLS IN TITANIUM BINDER

Kiev SVERKHTVERDYIE MATERIALY in Russian No 2, Feb-Mar 87 (manuscript received 24 Jun 86) pp 27-29

[Article by V. P. Pereyaslov, L. P. Primak, M. N. Voloshin, V. P. Gordiyenko and V. P. Kolomiyets, Superhard Materials Institute, Ukrainian Academy of Sciences]

[Abstract] The most promising method for manufacturing diamond tools with titanium binder is sintering at high pressures with very rapid heating of over  $10^6$ °C/sec to avoid interaction between the particles of diamond and powdered titanium. The initial titanium powder used in the process requires no special treatment. Close contact of the diamond with the binder is ensured with the formation of very thin layers of TiC. Diamond particles do not change their shape and retain their initial strength. Laboratory testing of special diamond disks by grinding of various ceramic materials was used to evaluate the usage properties of composites produced by this method. Disks using the titanium binder were found to require less cutting force than disks made by traditional methods. References 4: all Russian.

6508/9835

CSO: 1842/155

UDC 539.04:621:039.616

$\alpha \rightarrow \gamma$  TRANSFORMATION IN IRON-NICKEL ALLOY UPON ARGON ION BOMBARDMENT FROM A DC GLOW DISCHARGE

Moscow FIZIKA I KHIMIYA OBRABOTKI METALLOV in Russian No 2, Mar-Apr 87 (manuscript received 24 Mar 86) pp 13-17

[Article by V. N. Polunin, I. G. Sidortsov, I. A. Dubovtsev, P. P. Stanchula and V. I. Sheshin, deceased, Zernograd]

[Abstract] Structural-phase conversions in an Fe-Ni-Sn alloy (70:29:1 wt.%) were studied by nuclear  $\gamma$ -resonance spectroscopy as low-energy argon ions



produced by a dc glow discharge bombarded the alloy. Iron-nickel foil specimens 10  $\mu\text{m}$  thick were placed on the cathode of a glow discharge installation with parallel-plate stainless steel electrodes in a chamber with an argon pressure of 1.33 Pa. The maximum argon ion energy was about 3.2 keV, current density about 0.07 mA/cm<sup>2</sup> and bombardment dose 10<sup>18</sup>-10<sup>19</sup> ions/cm<sup>2</sup>. The bombardment was found to accelerate the diffusion process of movement of defects and defect systems, which propagated into the deeper layers of the alloy, causing atomic restructuring in the  $\alpha$ -phase related to the formation of a long-range order of the Fe<sub>3</sub>Ni type. Acceleration of diffusion was also facilitated by the large number of interphase boundaries. Ordering, by decreasing the temperature of direct and reverse conversion between  $\gamma$ - and  $\alpha$ -phases, causes restructuring and transition of the ordered BCC phase to an ordered FCC phase. Formation of large numbers of defects in the bombarded zone and the resultant acceleration of diffusion processes leads to structural and phase changes which propagate through the entire thickness of the specimen, which is significantly greater than the free path length of ions in the metal. References 17: 12 Russian, 5 Western (3 in Russian translation).

6508/9835  
CSO: 1842/144

UDC 669.1,669.295:537.533

#### INFLUENCE OF LOW ENERGY ION IMPLANTATION ON MECHANICAL PROPERTIES OF TITANIUM AND IRON ALLOYS

Moscow FIZIKA I KHIMIYA OBRABOTKI METALLOV in Russian No 2, Mar-Apr 87  
(manuscript received 22 Jul 86) pp 18-24

[Article by V. O. Valdner, V. P. Kvyadaras, G. A. Yermakov, V. F. Terentyev, N. A. Makhlin and A. G. Bochvar, Moscow]

[Abstract] Methods of ion implantation of metallic materials have not been well developed. Radiation processes such as the formation of structural defects, ion mixing, atomization and the related redistribution of materials on the surface may be very significant. This article discusses some principles to be followed in the design of low-energy implantation devices and suggests such a device that allows the principles to be implemented. A diagram of the device is presented as well as results of experiments with flat specimens of low-carbon steel and titanium. Ion modification of the surfaces of these materials with nitrogen ions significantly increases cyclical strength while decreasing ductility. When the bombardment temperature is increased to 450-500°C, the ductility of the titanium is not increased. Static extension of the titanium shows an area of yield, with a maximum at 450°C bombardment. The dose dependence of steel surface hardness shows a saturation area. References 15: 6 Russian, 9 Western (1 in Russian translation).

6508/9835  
CSO: 1842/144

## PROPERTIES OF DEFECTS GENERATED BY PULSED LASER RADIATION IN GaP

Moscow FIZIKA I KHIMIYA OBRABOTKI METALLOV in Russian No 2, Mar-Apr 87  
(manuscript received 23 Sep 86) pp 25-27

[Article by K. K. Burdel, T. Ditrikh and N. G. Chechenin, Moscow]

[Abstract] A study is made of the structural and thermal properties of defects generated by laser radiation in GaP crystals irradiated in air by a single pulse from an eximer (XeCl) laser at  $\lambda = 308$  nm,  $\tau = 20$  ms, with energy densities  $W = 0.26, 0.42$  and  $0.76$  J/cm<sup>2</sup>. Specimens were analyzed by the method of Rutherford back scattering and channeling. The eximer laser pulses caused formation of a phosphorus-rich layer on the surface, above a layer rich in gallium. The Rutherford back scattering spectra in nonoriented position and in channeling mode, energy dependence of dechanneling cross section and thermal properties of the defect layer indicated that the disruption of the stoichiometric composition determined the defect content of the area. Disruption of stoichiometry and possible decomposition of the compound determined the basic characteristics of defect formation in the complex semiconductors. References 5: 2 Russian, 3 Western.

6508/9835

CSO: 1842/144

## LASER TREATMENT OF IRON-MANGANESE STEEL

Moscow FIZIKA I KHIMIYA OBRABOTKI METALLOV in Russian No 2, Mar-Apr 87  
(manuscript received 22 Jul 86) pp 47-49

[Article by L. S. Malinov, Ye. Ya. Kharlanova, S. V. Danno and A. V. Lisakovich, Zhdanov]

[Abstract] Studies were made of steels types 03G8, 03G10, 05G22, 110G13 and 100G6F2, selected because of their different initial structures as tested. Laser heat treatment was performed on an LGN-702 laser, output power 800 W, laser spot diameter 1.1-3 mm, movement speed 100-400 mm/min. Durometric, microscopic and x-ray studies were performed. In low-carbon martensitic steels, 03G8 and 03G10, laser hardening sometimes decreased microhardness. In steels with  $\epsilon + \gamma$  times, largely by producing martensitic phases. References 6: all Russian.

6508/9835

CSO: 1842/144

INFLUENCE OF PLASTIC DEFORMATION AND HIGH TEMPERATURE AGING ON SHAPE MEMORY EFFECT IN Cu-Al-Ni ALLOY

Moscow FIZIKA I KHIMIYA OBRABOTKI METALLOV in Russian No 2, Mar-Apr 87  
(manuscript received 16 Jan 86) pp 123-129

[Article by A. Yu. Vasilenko, Voronezh]

[Abstract] A study is made of the mechanism by which mechanical and heat treatment influence the shape memory effect in Cu-Al-Ni alloy with  $\beta_1 \rightarrow \beta'_1$  transformation. Studies were performed on specimens of alloys containing 13.3 and 13.4 wt.% Al, 5 wt.% Ni and remainder Cu occurring as single crystals in the high temperature  $\beta_1$  phase state. The influence of plastic deformation by compression below the martensitic point and annealing at 300°C on subsequent manifestation of the shape memory effect was studied. The variation in shape recovery as a function of 300°C annealing time was found to be similar to the variation as a function of load applied in compression except for changes in the first cycle of heating after compression. Shifting of the temperature band of shape recovery after plastic deformation was related primarily to an increase in the resistance of the movement of the martensitic plate boundaries, while after annealing at 300°C it was related to a change in matrix composition. Expansion of the temperature range of shape recovery resulted from an increase in the heterogeneity of the dimensions of martensitic plates and variation in the accumulated elastic energy per unit volume as a function of the fraction of martensite formed caused by the presence of dispersed defects in the form of accumulations of dislocations or segregations. References 15: 5 Russian, 10 Western (1 in Russian translation).

6508/9835

CSO: 1842/144

UDC 613.164+613.165:621.793.7

HYGIENE-STANDPOINT EVALUATION OF ACOUSTICAL AND OPTICAL CHARACTERISTICS OF SPUTTERING PROCESS WITH HIGH-ENTHALPY PLASMA-GENERATING GAS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 3, Mar 87 pp 3-4

[Article by M. G. Fridlyand, candidate of technical sciences, and V. A. Pershin, engineer, State Institute for the Planning of Nickel Industry Enterprises, I. S. Alekseyeva, candidate of medical sciences, and K. A. Andreyev, engineer, All-Union Scientific Research Institute for Labor Safety]

[Abstract] Replacement of inert gases (He, Ar, Ar + H<sub>2</sub>) with high-enthalpy gaseous carbon compounds (CH<sub>4</sub>, CO<sub>2</sub>) as plasma-generating medium for sputtering ensures erosionless operation of a continuously renewable plasmatron cathode as well as otherwise better technical and economic process performance indicators. A performance evaluation must include not only acoustical and optical characteristics of the sputtering process with a glowing plasma arc but also industrial hygiene aspects, acoustic noise and electromagnetic radiation being of main concern. Such an evaluation was made in a study of a plasmatron using CH<sub>4</sub> + CO<sub>2</sub> mixture, the CH<sub>4</sub>:CO<sub>2</sub> volume ratio varying from 1.2 to 1.5, with the current varied over the 150-300 A range and the total gas rate varied over the 1.3-2.3 m<sup>3</sup>/h range. Acoustic noise was measured with RFT-GDR precision instruments including octave-band filters at a distance of 1 m from the plasmatron. Electromagnetic radiation was measured with thermoelectric transducers from the Leningrad Electrical Engineering Institute and the All-Union Scientific Research Institute for Industrial Safety, covering regions of the spectrum (near ultraviolet 0.2-0.4 μm wavelengths, visible 0.4-0.7 μm wavelengths, near infrared 0.7-1.5 μm wavelengths, for infrared 3-17 μm wavelengths) separately as well as integrally (0.2-3 μm wavelengths). An analysis of the data revealed a maximum noise intensity within the 4-8 kHz frequency range, just as that from an Ar + H<sub>2</sub> plasmatron, its level reaching 114-120 dB and thus 1.5-1.8 times higher than physiologically acceptable according to the loudness chart but with an integral-spectral intensity of electromagnetic radiation much lower than that from an Ar + H<sub>2</sub> plasmatron. Acoustic noise and electromagnetic radiation can be abated by operation at a lower current level. Personnel safety can be ensured by automation of the sputtering process, with remote control, in hermetic plasma chambers. S. O. Bogdanovich, M. I. Pashkova, N. V. Potanina and A. K. Storchak participated in the study. References 6: 5 Russian, 1 Western (in Russian translation).

2415/9835

CSO: 1842/133

## EXPLOSION-PROOFING HYDROELECTROLYTIC EQUIPMENT FOR GAS-FLAME PROCESSES

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 3, Mar 87 pp 5-6

[Article by V. I. Skvortsov, candidate of technical sciences, and B. V. Khmelniker, engineer, All-Union Scientific Research and Design Institute for Gas Welding and Gas Cutting Machine Building]

[Abstract] Oxygen for gas-flame welding or cutting is economically and efficiently produced by electrolysis of water, the apparatus being most effectively explosion-proofed by feeding oxygen and hydrogen to the burner separately. The probability of backfiring, a good reliability and safety indicator, should not exceed 5% while the probability of backfiring in an  $H_2-O_2$  mixture reaches 1.0 during each turn-off. The probability of explosion can be reduced by means of flame quenchers, porous guards inside the burner. The design of such guards is optimized on the basis of a process analysis including complete combustion in accordance with the equation  $H_2 + 0.285 O_2 = 0.57 H_2O + 0.43 H_2$ . Theoretical calculations have yielded a critical pore diameter of  $122 \mu m$ , based on the Peclet number at the quenching limit and thermodynamic characteristics of the gas mixture. Guard disks made of cermet material from Ti powder with the maximum pore dimension varied over the 60-140  $\mu m$  range were tested, for verification, under a pressure varied over the 0-0.2 MPa range in gas mixtures containing 30-90%  $O_2$ . An analysis of the data has yielded an empirical relation describing the dependence of the critical flame-quencher pore diameter on the gas composition and pressure with an error not larger than 10%. A 45%  $H_2 + 55\% O_2$  mixture under a pressure of 0.15 MPa is the most dangerous and the critical pore diameter is more likely to be 80  $\mu m$ . References 2: both Russian.

2415/9835

CSO: 1842/133

## ARC WELDING OF THIN-WALLED PIPES MADE OF VANADIUM ALLOY WITH CHROMIUM COATING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 3, Mar 87 pp 10-11

[Article by V. V. Tsykanov, engineer, and Ye. M. Tabakin, engineer]

[Abstract] Arc welding of thin pipes made of the V + 2.5% Zr + 0.1% C alloy with 20-30  $\mu m$  thick Cr coating was evaluated experimentally on specimens 6 mm in diameter with 0.3 mm wall thickness. Welding was done with plugs of the same alloy and with a tungsten electrode, at rates of 15-25 m/h, using direct current of 30-38 A magnitude and direct polarity inside a He chamber. Specimens had been pretreated by chemical etching with a HF-HNO<sub>3</sub>

acid mixture. The joints were tested for mechanical strength under internal pressure. Metallographical examination of seams, including x-ray spectral microanalysis and microhardness measurement, for phase composition and Cr distribution indicates that, in order not to degrade the mechanical characteristics of a welded joint, the Cr content in the seam must not be higher and thus the coating must not be thicker than necessary for ensuring adequate corrosion resistance. In order to ensure uniform distribution and thus maximum effectiveness of Cr, it is expedient to insert a 0.1-0.15 mm thick ring of a low-Cr alloy between the welded pipe pieces. References 3: 2 Russian, 1 Western.

2415/9835

CSO: 1842/133

UDC 621.791.052:629.12.037.4

#### EFFECT OF HEAT TREATMENT ON CHARACTERISTICS OF HARDFACING METAL ON MARINE PROPELLER SHAFTS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 3, Mar 87 pp 17-19

[Article by F. N. Ryzhkov, doctor of technical sciences, Voronezh Polytechnical Institute, and V. Ye. Magidenko, candidate of technical sciences, Komsomolskna-Amure Polytechnical Institute]

[Abstract] Hardfacing of marine propeller shafts with Sv-12Cr13 or Sv-04Cr19Ni11Mo3 wire, as well as with Sv-10Cr22Ni7SiTi or Sv-09Cr16Ni25Mo6VN<sub>2</sub> wire, was evaluated experimentally on such shafts made of St20 steel and 56 mm in diameter. Hardfacing was done in three layers formed by four-entry helices each, at a rate of 0.5-0.6 m/min with an arc voltage of 30-32 V and with the arc current varied over the 190-210 A range (210-320 A for Sv-12Cr13 wire). Hardfacing was done with the shaft temperature stabilized at 200-250°C and was followed by tempering for relief of residual stresses. Comparative evaluation of the hardfacing alloys with widely different chemical compositions included standard corrosion tests by the potentiodynamic method with a voltage sweep in 0.05 V steps in 3% aqueous NaCl solution for intergranular corrosion and pitting, electrochemical tests by the capillary method in 0.2 n HCl solution at room temperature, and standard mechanical tests on 3 mm thick specimens. The results of these tests and of microstructural examination indicate that Sv-12Cr13 hardfacing is mechanically the strongest and least plastic prior to immersion in sea water, but its corrosion resistance and that of Sv-09Cr16Ni25Mo6VN<sub>2</sub> hardfacing are lowest. The mechanical strength of all these hardfacing alloys was found not to be fully restored by tempering after stabilizing heat treatment. While the Sv-04Cr19Ni11Mo3 alloy with at least 7-10%  $\delta$ -ferrite phase has an adequately high corrosion resistance after tempering of hardfaced shafts at 700°C, hardfacing with the ferritic-austenitic Sv-10Cr22Ni7SiTi alloy ensures after tempering the best combination of mechanical characteristics and corrosion resistance. References 6: all Russian.

2415/9835

CSO: 1842/133

## MORPHOLOGICAL CHANGES IN COMPOSITE MATERIALS BASED ON POLYVINYL CHLORIDE DURING HIGH-FREQUENCY WELDING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 3, Mar 87 pp 19-20

[Article by Ye. S. Pavlova, engineer, G. M. Kuznetsova, engineer, M. A. Pronin, engineer, V. K. Maksimova, candidate of chemical sciences, V. N. Sokolov, candidate of chemical sciences, and L. M. Fedorov, candidate of chemical sciences, Ivanovo Scientific Research Institute of Film Materials and Technical-Grade Synthetic Leather]

[Abstract] The effect of electric welding with high-frequency current on composite materials consisting of polyvinyl chloride PVC-70 and acrylonitrile-butadiene styrene ABS 2501-K modified with thermoplastic polyurethane TPU-14 was studied experimentally on 0.1 mm thick films produced by rolling at a temperature of 423-433 K for 2 min with frequent changes of direction and with subsequent compaction under a pressure of 15 MPa at 423 K. Films of seven such materials, with the PVC:ABS:TPU ratio ranging from 1:0.8:0.2 to 1:2.5:1.5, were produced and pieces of each material welded together in a UEP2200A machine operating at a frequency of 27.12 MHz with a 20 mm thick and 100 mm wide flat electrode. Welding seams were tested for density and frost resistance under mechanical impact by dropping a mass of 1 kg from a height of 0.5 m. While the density of seams was found to be either higher or lower than that of the adjacent cold films, the subzero temperature at which fracture under impact occurred was found to be 5-10 K higher (233-243 K) in most cases and only for the PVC:ABS:TPU = 1:1.67:0.67 material the same (233 K). Except in this case, accordingly, the frost resistance of welding seams is lower. This is confirmed by results of microstructural examination, which has revealed morphological changes such as foliation, braid formation, and precipitation of TPU with resulting stress concentration during welding. References 5: 3 Russian, 2 Western (both in Russian translation).

2415/9835

CSO: 1842/133

## CHARACTERISTICS OF SOLDERING CERMET ASSEMBLIES WITH Cu-Ti SOLDERS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 3, Mar 87 pp 12-13

[Article by V. L. Grishin, candidate of technical sciences]

[Abstract] Soldering of cermet seal assemblies with Cu-Ti solders was evaluated experimentally on ceramics with high  $Al_2O_3$  content (KP-1, TSM-300/301) and Mo, Nb or Fe-Ni 42 alloy as reinforcement. In addition to vacuum-tightness, insulation resistance and mechanical strength of seams

as seal performance criteria. Spreadability and wettability, the latter characterized by the critical angle, served as solder performance criteria. Accordingly, the 80 Cu + 20 Ti alloy was found to be most suitable as solder material with a TiCu phase forming at lower temperatures (900-950°C) and a Ti<sub>2</sub>Cu phase forming at higher temperatures. This has been confirmed by x-ray structural examination and microhardness measurements. Maximum vacuum-tightness was obtained by leaving a 0.05-0.08 mm wide clearance between ceramic and metal so as not only avoid solderless contact but also minimize internal stresses in the joint. On the basis of 3-5 min holding tests, 1050°C was found to be the optimum soldering temperature. Seals assembled with this solder have lasted more than 1000 h at a temperature of 600°C in air and have withstood 20-650-20°C temperature cycles in vapors of alkali metals as well as vibration with 25 g linear acceleration at frequencies of 2-2000 Hz. References 2: both Russian.

2415/9835  
CSO: 1842/133

UDC 621.791.037;621.792;669.14

#### INTERACTION OF SINTERED POWDERS OF METAL AND CERAMIC-METAL MATERIALS WITH STAINLESS STEEL MELT

Kiev POROSHKOVAYA METALLURGIYA in Russian No 3, Mar 87 (manuscript received 9 Apr 86) pp 77-83

[Article by F. F. Yegorov, G. V. Gorbunov, V. P. Smirnov and V. F. Berestyan, Institute of Materials Science Problems, Ukrainian Academy of Sciences]

[Abstract] A study was made of the interaction of the materials of nonfusible electrodes of various compositions with a melt of stainless steel, widely used in welding. Tablets of tungsten, molybdenum, titanium nitride and titanium nitride with chromium with various contents of chromium as well as of NKTm metal ceramic were wet with stainless steel type Kh18N10T in a furnace using a special support which located the specimen in the horizontal plane. Titanium nitride was not wet with the stainless steel. The contact wetting angle of this material and the NKTm was 90°, and did not change with time. Wettability of the TiN-Cr material depended significantly on chromium content, contact wetting angle decreasing with increasing chromium concentration up to 70%, then dropping to 0. The stainless steel interacted with tungsten and molybdenum, forming solid solutions and intermetallics. References 4: all Russian.

6508/9835  
CSO: 1842/124



## PARAMETERS OF LASER RADIATION IN WELDING WITH DEEP MELTING

Moscow FIZIKA I KHIMIYA OBRABOTKI METALLOV in Russian No 2, Mar-Apr 87  
(manuscript received 13 Oct 86) pp 40-46

[Article by V. M. Ganyuchenko, Leningrad]

[Abstract] A theoretical mathematical study is presented of the basic characteristics of laser radiation used for welding with deep melting to achieve minimum plasma formation at normal gas pressure. The problem is solved by regularization of the formation of vapor in the vapor-gas channel with respect to time. Regularization requires synchronization of processes of growth of the layer of the liquid phase on the forward wall of the vapor-gas channel and its removal over the entire depth of the channel. This is equivalent to the condition of flatness and parallelness of the temperature field through the thickness of the material. This condition can be achieved by uniform distribution of radiant energy absorption density through the depth of the channel. The thermal efficiency of periodic destruction of material of the front wall of the vapor-gas channel by melting with pulse lengths of  $10^2$ - $10^{-4}$  sec is approximately proportional to the permissible overheating of the melt, and reaches 80% for short pulses. The calculated melting capacity of a beam in combined mode is greater than the values characteristic for traditional laser welding methods and is not inferior to the melting achieved by the electron beam method. References 14: 9 Russian, 5 Western. (1 in Russian translation).

6508/9835

CSO: 1842/144

## ESTIMATING TEMPERATURE CONDITIONS OF THE SEAM ZONE IN EXPLOSIVE WELDING

Moscow FIZIKA I KHIMIYA OBRABOTKI METALLOV in Russian No 2, Mar-Apr 87  
(manuscript received 13 May 85) pp 77-80

[Article by G. N. Epshteyn and P. A. Mogilevskiy, Moscow]

[Abstract] The temperature in the welded seam zone in aluminum and copper explosively welded at up to 50 GPa pressure is calculated. It was assumed that the collision of the plates instantly increased the temperature, causing melting to a depth of 5  $\mu$ m on either side of the interface. The calculations showed that at a collision pressure of up to 30 GPa, the cooling time, even when the surface layer is melted, is about  $10^{-7}$  sec, comparable to the time of action of the shock wave. The temperature aftereffect therefore cannot influence processes of structure formation, including the rate of mass transfer. The cooling speed is sufficient to produce an amorphous layer in the welded seam zone in alloys with that tendency. References 8: 6 Russian, 2 Western.

6508/9835

CSO: 1842/144

UDC 622.343/.344.012(574)

INTENSIFICATION OF MINING IN NONFERROUS METALLURGY IN KAZAKHSTAN

Moscow GORNYI ZHURNAL in Russian No 3, Mar 87 pp 3-4

[Article by Candidate of Technical Sciences, B. D. Lerman, Chief Engineer, Special Planning-Design and Technological Bureau, Mintsvetmet KazSSR [Kazakh SSR Ministry of Nonferrous Metallurgy]; A. P. Belousov, Leading Engineer, and I. I. Yasonov, Chief Mining Engineer, Science and New Technology Administration, Mintsvetmet KazSSR]

[Text] Today's nonferrous metallurgy in the Kazakh SSR is a highly developed and economically efficient branch of national economy of our country. Its technical level is constantly improving, which makes it possible to make a decent contribution in meeting the ever growing national economic demand for nonferrous metals. In the 12th Five-Year Plan, it is planned to realize considerable savings because of cost reduction due to the improved technical level of mining.

In order to reach plan indices on improving the technical level of production one must solve a number of problems, mainly those related to the need to compensate for deteriorating mining conditions. Thus, over the last 15 years lead and zinc content in ore has decreased by 16%, whereas copper content has decreased by almost 50%. During the same period, copper content in Dzhezkazgan ores has decreased by 11%. Besides, the accepted technology for working the deposits does not ensure complete extraction of reserves and therefore a considerable amount of ore with high metal content remains in the ground. Huge losses were allowed in working the Dzhezkazgan and Mirgalimsay deposits, where panel-pillar and chamber-pillar mining systems are mainly used. Thus, average losses were equal to 20% at the Dzhezkazgan GMK [mining-metallurgical combine] and to 23% at the Achpolimetall combine.

The systematic increase in national economic demand for nonferrous, rare and noble metals calls for constant increase of mining volumes, both in open-pit and underground mining. At present, the volume of mine materials is equal to 102.9 million m<sup>3</sup>, and by the end of the 12th Five-Year Plan it is supposed to reach 106.4 million m<sup>3</sup>. And the volume of mine materials per 1 ton of mined metal increases sharply.

It is these very factors that have determined further trends in development of mining during the 12th Five-Year Plan:

the use of equipment with high unit capacity and productivity;

improvement of systems for underground ore mining;

production implementation of technological innovations and advanced production processes.

Large open-pit mines in the republic's nonferrous metallurgy are equipped with modern roller-bit drilling rigs SBSH-250MN, 27 and 40 tons dump trucks, electric locomotives with a pulling strength of 100-150 tons, 95-100 ton dump cars and EKG-4,6 and EKG-8I excavators. During the 12th Five-Year Plan, excavators with shovel capacity of 8 and 12.5 m<sup>3</sup> and 110 ton dump cars will be introduced. In 1990, it is planned to mine 38 million m<sup>3</sup> of mine materials, using equipment with high unit capacity. However, it should be noted that retooling of open pits is proceeding not as fast as one would wish. Thus, in 1986 nonferrous metallurgy enterprises in Kazakhstan did not receive nine high-capacity BelAZ-7519 dump trucks. Due to the planned increase of open pit mining and the increasing depth of open pits, the scarcity of labor, energy and material resources and mining and transportation equipment will be getting more acute. One of promising ways for solving this problem is conversion to combined schemes of open pit transportation. It is planned to put in operation an inclined skip hoist at the East Kazakhstan copper and chemical combine and a conveyor hoist for conveying ore mass at the Zhayrem mining and concentrating combine.

The main trend in underground mining is improvement of mining systems, based mainly on the use of self-propelled mining equipment that makes it possible to increase the labor productivity of the face crew by a factor of 1.5 to 2. It is planned to increase the share of ore mining by employing self-propelled equipment to 60%. This will make it possible to considerably reduce labor expenditures and cost of ore and save materials and fuel and energy resources. It is also planned to expand application of mining systems with filling worked space, which makes it possible to reduce underground ore losses and solve a number of other complicated problems in mining. By the end of the Five-Year Plan, the share of ore mining with filling worked space will reach 26%.

As filling technology and mining systems with filling have been improving, a trend to use cement-containing hardening mixtures for filling has emerged. In 1985, the share of hardening filling in the total volume of filling at Kazakhstan nonferrous metallurgy enterprises was equal to 77%, whereas at the Zhezkent mining and concentrating, Tekeli lead-zinc and Achisay polymetal combines and at the Tishinsk mine of the Leninogorsk integrate polymetal works it was equal to 100%. The cost of filling is high and is equal to 9.87 R at the Dzhezkazgan GMK, 13.6 R at the Zhezkent GOK [mining and concentrating combine], 9 R at the Tekeli lead and zinc combine, 6.3 R at the Zyryanovsk lead combine, 4 to 9 R at the Leninogorsk PMK [polymetal combine], 7 to 14 R at the Irtysh PMK and 4.6 R at the Achisay PMK per 1 m<sup>3</sup>. Therefore, the main trend in further improvement of filling work and systems of working with filling is to expand application of hardening filling with

low cement consumption and of hydraulic and rock filling and automation of filling complexes. It is planned to use depleted slags of the Dzhezkazgan copper smelting plant and dry TETs [heat and power station] ash. This will make it possible to reduce cement consumption by 20-30% and reduce the cost of ore mining. Due to improved technology, cost of ore mining will decrease, as will the consumption of materials and fuel and energy resources.

Production implementation of technical innovations and advanced technology will be also going along other directions. In working thin, steeply dipping vein deposits, it is planned to introduce mechanized breaking complexes KOV-25, KPV-6 and PV-100, which will make it possible to increase the labor productivity of stope workers by a factor of 3 to 5. Savings from introducing the complexes will be equal to 1 million R. These complexes will be implemented at the Akchatau and Belogorsk GOKs and Irtysh polymetal combine.

Great attention will be paid to increasing the volume of accelerated cutting by using high-efficiency equipment. The volume of accelerated cutting during the Five-Year Plan will exceed 120,000 meters. This will make it possible to cut the cost of ore mining by almost 3 million R, cut labor expenditures and save about 800,000 R worth of fuel and energy resources. In order to do this, the Akchasay combine will organize manufacturing of cutting complexes APK-2, designed by the combine.

In cutting raises, it is planned to use mechanized KPV and KPN complexes and 2KV miners. Using these machines, 59,000 m of vertical and inclined mine workings will be worked during the five-year plan. In 1990, the share of mechanized working of raises will be equal to almost 90%, whereas virtually all between-floor and block raisings will be worked using a mechanized method. The most promising trend in this field is manless working of raises using the method of full-section drilling with 2KV miners. At present, three such miners are in operation (at the Zyryanovsk SK [lead combine], Tekeli ShSU [mine construction administration] and Leninogorsk PMK), but by the end of five-year plan there will be nine of them. This cuts the cost of ore mining by more than 500,000 R, frees up 100 workers for other jobs and saves about 380,000 R worth of materials and energy resources.

In supporting mine workings, one will use advanced types of supports, such as steel-polymer, latex-spray cement and metal pipe. Accelerated strength gain of these types of supports, compared to regular reinforced concrete anchors, will make it possible to support workings while a face moves forward. During the five-year plan, the use of these types of supports will increase several-fold. It suffices to say that at Dzhezkazgan mines it is planned to increase the volume of support, using steel-polymer anchors, five-fold. For this purpose, a production department for manufacturing ampules for steel-polymer supports will be built, whereas special machines AKP-8, developed by DzhezkazganNIPItsvetmet [Dzhezkazgan Scientific Research and Planning Institute of Nonferrous Metallurgy], will be used for anchor installation.

A trend toward integrated mechanization of blasting operations has been adopted. All operations, from unloading VV [explosives] from rail cars to charging blast-holes, will be performed by machines and mechanisms. In 1990,

50% of the total VV volume at open pit mines and 18% at underground operations will be charged using integrated mechanization. It is planned to completely mechanize processing of industrial VV at the Balkhash and Dzhezkazgan GMK, Leninogorsk PMK and Zyryanovsk SK. At the Blakhash GMK and Leninogorsk PMK, VV will arrive in soft one-ton containers. Therefore, it is planned to build special sites, equipped with material handling mechanisms, at base explosives warehouses. In the long run, all combines will be converted to this technology.

The scientific and technical progress in mining is closely related to the output of machines, mechanisms and high-efficiency equipment.

In the Basic directions for the economic and social development of the USSR for 1986-1990 and for the period up to the year 2000, approved by the 27th CPSU Congress, the main part in accomplishing the scientific and technical revolution is assigned to the machine-building industry, and necessary money has been appropriated for its expansion. Indeed, without expanding the machine-building industry, miners' plans might go unfulfilled. Lack of machines and high-efficiency equipment has been felt at Kazakhstan nonferrous metallurgy enterprises for a long time. For instance, PKU machines for breakage of mine workings are manufactured in series. However, annual demand of Kazakhstan nonferrous metallurgy enterprises for these machines is only satisfied by 15-20%. The Kazakh SSR Gossnab [State Committee for Material and Technical Supply] could have helped in obtaining the PKU. An AKP-8 machine for installation of steel-polymer rods was released for series production to Vostokmashzavod [Eastern machine-building plant] imeni 50-letiya SSSR two years ago. However, its production has not been organized yet. Manufacturing of MDZ-1M charge-delivery machines is included in the production plan of this plant every year; however, the plant has not organized production of these machines yet, whereas production of similar "Zyryanovsk" machines had been discontinued 10 years ago. As a result, the level of mechanization of blasting operations is low.

Employees of Kazakhstan nonferrous metallurgy are quite sure that the stockpile in the machine building industry during the 12th Five-Year Plan will subsequently ensure a significantly higher pace of improving efficiency of mining. During the five-year plan, the program of intensification of mining will ensure a reduction of labor expenditures equivalent to additional ore output by two large mines.

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ASSESSMENT OF RAW MATERIAL RESOURCES BASE AND PROSPECTS FOR EXPANSION OF  
INTEGRATED MINING AND INDUSTRIAL OPERATIONS

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[Text] The Basic directions for the economic and social development of the  
USSR for 1986-1990 and for the period up to year 2000 pay special attention  
to further expansion of integrated production that ensures full and integrated  
utilization of natural resources and reduces adverse environmental effects.

In recent years, the volume of excavated mine material in mining mineral re-  
sources has reached about 20 billion tons. Out of this amount, the mineral  
resources per se do not exceed 5 billion tons, and only 10% (from 1 to 10%,  
according to some estimates) of the entire mine material extracted becomes  
part of end industrial products (steel, energy, mineral fertilizers etc.).  
Thus, about 90% of excavated mine material, with huge amounts of money  
spent to mine it, is stored in dumps and tailing ponds and virtually consti-  
tutes mining waste.

Storing this waste in dumps, refuse heaps and slime and tailing ponds  
involves certain expenses and diverts large land areas that are often fit  
for agricultural use. As a result of mining, about 50,000 hectares of land  
are damaged annually. For storing waste of concentrating mills alone,  
about 1 million hectares of land is taken over the country [1]. There is  
a certain danger in the fact that dust, blown and leached from dumps and  
refuse heaps, contains particles of metals and other chemical compounds  
which fall out and can accumulate in ponds and soil or have increased air  
concentration.

Along with ecological, there are also complex economic consequences of  
mining and consumption of minerals in their present form and volume. During  
the 11th five-year plan, 47% of the total volume of industrial capital  
investment was allocated for the mining industry. Such a large share can be

explained not just by large production volumes and high capital intensity, but also by the specific character of production in this industry, due to unavoidable depletion of reserves of mineral resources in certain areas of deposits and in entire deposits. This forces one, in order to maintain the achieved production level, to make considerable capital investment for deeper mining and exploitation of new deposits, without increasing the volume of mining in the country as a whole. According to calculations, provided there will be no radical changes in the technological base, one would have to create in the very near future new fixed assets in mining industries equal to those created over the entire preceding history of our state.

Integrated processing of raw materials and creation of no-waste and low-waste technologies is one of the ways to solve the problem of increasing efficiency of mine material utilization. One should bear in mind that, because of large volume of mine material that is currently not utilized, it is not possible to completely solve these problems within the framework of mining industries. It is therefore necessary to consider the entire technology chain, from mining of minerals to initial processing thereof.

Solution to the problem of wasteless utilization of mine material excavated in the process of mineral mining is to a large degree related to the development of forms of organization of social production, with integration identified by V. I. Lenin as one of the most important ones. According to him, integration is "combining in one enterprise various industries that either represent successive phases of processing of raw materials (for instance, making pig iron from ore and converting pig iron to steel, with possible later manufacturing of finished products from steel) or play ancillary roles for each other (for instance, processing of wastes or by-products; manufacturing of packaging products etc.)" (Lenin, V. I., "Imperialism kak vysshaya stadiya kapitalizma" [Imperialism: Highest Phase of Capitalism], Complete Works, Vol 27, p 312).

Successive phases of processing of raw materials represented the first form of integration. It is based on Lenin's thesis of bringing production closer to sources of raw materials. As early as during the first five-year plans, the first coal and metallurgical base was created in the Ukraine, then the Urals-Kuznetsk metallurgical combine followed, etc. This form of integration is being successfully implemented at present too. As a result, enterprises are located closer to natural resources.

The scientific and technical progress has created prerequisites for more thorough processing of mineral resources and increasing the volume of products obtained from a single deposit. In nonferrous metallurgy, polymetallic ores are processed. Integration based on integrated utilization and sequential processing of raw materials is widely used in the oil and gas industry.

Wide-scale practical implementation of integrated processing is held back by the departmental separation of enterprises. As a rule, potential products of other industries end up in dumps.

Thus, in exploitation of shale deposits in the Estonian SSR and in Leningrad oblast (the town of Slantsy), about 17 million tons of waste per year, in the form of shale rock and screenings of crushed stone made of the rock, goes to dumps. By now, over 120 million tons of this waste has accumulated. Its storage volume exceeds 100 million m<sup>3</sup>, and it takes up about 1,000 hectares of land.

It has been proved that this waste can be utilized very efficiently as fillers in manufacturing polymer construction materials and for lime pretreatment of acid soil in agriculture [2, 3].

In most cases, integration by using the above forms is conducted within the framework of enterprises that are part of the same industry. Such integration does not make it possible to solve the problem of utilization of the large-scale waste which is characteristic of mining enterprises. In order to eliminate this drawback, which is the result of the contradiction between the industry branch character of management and the territorial character of siting of integrated production, territorial-industrial complexes (TPK) have been formed in our country. These complexes are a set of technologically and economically interrelated and proportionally developing production units and enterprises that are subordinate to different ministries and agencies and concentrated within a limited territory and use the territory's resources and infrastructure. A TPK embraces specialized enterprises and industries that complement these enterprises and provide regional employment for labor resources, as well as the infrastructure, power-generating and construction base, transportation and social and cultural objects.

In a TPK, all forms of social production are integrated. In doing this, Lenin's idea, expressed in the above definition of integration of industrial production, is preserved. However, in this case an enterprise is not a traditional production entity (a combine, an association, a plant), but the entire TPK. Sequential processing and integrated utilization of raw materials are conducted within the TPK framework.

A number of factors indicate the need for integration within the framework of a group of enterprises. Thus, in order to reduce expenditures for creating reserves at mining enterprises for a non-stop operation during repairs, it seems feasible to integrate not just individual enterprises, but groups of enterprises of associated industries within a territory or a TPK. There are certain qualitatively new factors justifying this.

First of all, in the case of independent functioning of a number of elements stable results of their operation as a system are achieved then the share of reserve elements decreases as the number of elements increases. As a TPK includes several similar objects, this circumstance should be used for reducing the share of reserve units of equipment.

Second of all, in order to reduce reserve working space, it is feasible to use elements of production infrastructure that are common for a TPK. A common repair base (very powerful on a TPK scale) makes it possible to retire for preventive repairs not just individual pieces of equipment at various mining enterprises, but rather equipment of entire enterprises or quite detached sections thereof, at the same time.



Third of all, there are transportation lines between mining and processing enterprises of a TPK. In a fuel and energy type TPK, these connections are complemented by circuit completion of power-generating capacity, which makes it possible to redistribute flows of raw materials or fuel between suppliers and consumers thereof, without changing the total output of these complexes.

Solving of this problem can be facilitated, if associated units or enterprises in mining and processing industries are retired for preventive repairs at the same time.

Integration within the framework of a group of enterprises makes it possible to increase the extent of utilization of extracted mine material. An attempt to develop, both theoretically and practically, the idea of integration within the framework of a group of enterprises was made in [4]. Its author, G. G. Shalmina, proposes to integrate production operations not only by their main products, but also by associated overburden rock and production waste, and, using specific examples, she derives positive results. However, the methodological approach to the solution of this problem is close to being the traditional one. For deposits under consideration, customers are determined and the problem of optimization of flows of raw materials is solved, taking into account the economies of mining and processing of raw materials and expenses for transportation thereof. In doing this, calculations are made for both existing and newly developed technologies for processing raw materials. The version with the lowest production and transportation expenses is considered the reasonable one. Waste utilization is planned based on demand for a raw material, taking into account development prospects of a region.

Using this approach, one virtually optimizes the feasibility and sequence of development of mineral resources of a region and placement of mining enterprises. Although the extent of utilization of extracted rock increases, it still remains at an insufficient absolute level. Under these conditions, it has become necessary to supplement existing ideas on integration. In assessing a deposit, it should be considered not just a source of products of a certain industry, but rather a potential source of multi-component output obtained in the process of its mining, concentration and initial processing, taking into account possible variations.

The scientific and technical progress has resulted in diversification of technological solutions. For a single raw material, several technologies are developed that differ in implementation principles and products produced, including waste composition. This generates a new idea: integration diversification. Joint analysis of available technological processes at several enterprises makes it possible to find solutions, wherein waste of one enterprise can be considered and intentionally produced as a raw material for products of another enterprise. In some cases, objects for centralized waste processing or for intermediate conversion can be created for this purpose, that prepare waste of some enterprises for consumption by others, following the experience of production preparation in the Georgian and Ukrainian SSRs.

In this case, not just mineral resources will be used, but also overburden rock, which is not extracted when regular technology is used, or enclosing rock, extracted in bulk.

As an example, a version of joint development of the Seligdar or other apatite deposits of the Aldan group and of the Sakun synnirite deposit, with a possibility of using additional raw materials from other regions, was examined. The choice of objects was determined by the acute demand of Siberian and Far Eastern regions for nitrogen-phosphate and potash fertilizers, by a possibility to produce no-chlorine potash and nitrogen-phosphate fertilizers and soil deoxidizers, which is especially important for acid soils, which prevail in Siberia and the Far East, and by national economy demand for aluminum raw materials, rare elements and construction materials.

Ores in the Seligdar deposit are of an apatite-carbonate type; they are complex and contain admixtures of rare-earth elements. Average content of  $P_2O_5$  in the ores is rather high. The deposit is a single ore body, oval in shape, with a cross-section of  $1.96 \times 1.02$  km. The ores are hard to concentrate. The stripping ratio does not exceed  $0.65 \text{ tons/m}^3$ ; moreover about 50% of stripping is suitable for industrial utilization.

A sulphuric-acid scheme is suggested for processing apatites. However, the authors of this article think that for processing the Seligdar deposit a nitritic acid scheme is the most feasible one. In this case, it is possible to produce complex nitrogen-phosphate and nitrogen-phosphate-potash fertilizers, while at the same time efficiently extracting rare-earth elements as saleable products. This will make it possible to increase the efficiency of development of the deposit and to increase the extent of utilization of extracted rock.

Besides, it is possible to process forsterite dunites of the Ingali massif and hard-to-concentrate ores of the Seligdar deposit, producing fused calcium-magnesium phosphates, a valuable fertilizer.

In the process of making a mining and concentrating combine operational, 7 to 8 million  $\text{m}^3$  of carbonate crushed rock, which is a raw material for manufacturing construction materials, can be produced annually.

Synnirites are of interest as complex raw material for production of no-chlorine potash fertilizers, alumina, glass, ceramics, construction materials and rare metals.

They can be processed using various methods that have been suggested for nepheline raw materials, taking into account differences in their mineral composition. Known schemes are modifications of alkaline or acidic methods. When using alkaline methods, a lot of slime and cement is produced. The absence of the latter is an advantage of acidic methods.

Production of fertilizers in this region is also possible on the basis of the Nep deposit of potash salts, located in poor nature and climate conditions. Besides, additional expenditures are needed in order to dechlorinize products

obtained from these salts, or the need for soil deoxidizers increases if one uses chlorinated potash fertilizers.

To reduce waste and to form its composition in order to increase the degree of integrated utilization of raw materials, synnirites are processed in accordance with two technological schemes at the same time: a modified sintering scheme, wherein, in addition to alumina and complex potash-phosphate fertilizer, cement and belite slime are produced, and a combined scheme, wherein alumina, potassium sulphate, Si-stoff and silica gel are produced. In addition, other elements can be extracted as well.

Processing of synnirites in accordance with the sintering technology is feasible at low-capacity combines, due to difficulties in slime utilization, which forces one to use the acidic method. At the same time, the need to expand the construction industry in the region predetermines the need to use the alkaline method, because of the large amount of cement and belite slime in the waste. Therefore, in development of synnirite deposits it is proposed to perform processing, using partially the alkaline and partially the acidic method.

Production of apatite concentration from the Seligdar deposit and of alumina from synnirites can be considered interrelated production processes, because the output of one is a raw material for the other. If a modified sintering scheme is used for processing synnirites, the concentrate from this deposit should be used as a starting component. Waste (cement and belite slime), generated in the process, can be used, together with crushed rock from strippings, as a raw material for a reinforced concrete products plant.

It is feasible to use potash, obtained in synnirite processing, as a reagent in apatite concentrate processing.

For production of nitric acid needed for processing of synnirites from apatites of the Seligdar deposit using the nitrogen-acidic method, one can use natural gas from Yakut deposits.

In order to produce sulphuric acid, it was originally planned to use waste metallurgical gases of the Khrustalnyy GOK [mining and concentrating combine] and Norilsk GMK [mining and metallurgical combine] or native sulphur from the Kamchatka and Kuril islands deposits. At present, there are technological prerequisites for producing sulphuric acid from pyrite concentrates, which are waste of various production processes and are stored in large quantities in the Buryat ASSR as a result of centralized processing thereof. In order to do this, one should create a territorial center for processing pyrite concentrates and organizing delivery of raw materials.

The total volume of processing synnirites from the Sakun deposit was derived from technical and economic indices calculated from results of surveying work. The ratio of the modified and integrated schemes was determined by the possibility to produce such types of by-products as cement and belite slime.

Versions of processing apatites from the Seligdar deposit were derived based on demand for apatite concentrate, which is used in production of complex potash-phosphate fertilizer, obtained as a result of processing synnirites in accordance with the VAMI [All-Union Scientific Research and Planning Institute of the Aluminum, Magnesium and Electrode Industry] scheme. The output in terms of ore and concentrate (36.9%  $P_2O_5$ ) was determined in accordance with the prepared TEO [technical and economic justification].

Application of no-chlorine potash fertilizers, produced in processing synnirites, will make it possible to significantly reduce the amount of soil deoxidizers. Chalk, generated in the process of nitroammophos production, can be used for soil deoxidizing, in the construction and chemical industries etc. Si-stoff and silica gel constitute virtually pure silicon dioxide, with  $SiO_2$  content of 92 and 95%, respectively. It is feasible to use Si-stoff for production of adsorbents, glass and glass ceramics, as well as additives in production of construction materials. Silica gel in the form of silica white can be used as a filler in production of organic polymer materials and adsorbents and for catalysts.

Apatite concentration waste can be used for production of cement concretes and mortars as a filler for dense and cellular lime concretes, asphalt concretes and dolomite flour, as well as for production of cement and ceramic tile.

By varying technology of processing raw materials, one can change waste in order to attain the fullest possible utilization thereof, up to developing a no-waste technology. The degree of waste utilization can be determined from additional studies of demand and customers for these raw materials.

National economy use of wastes of integrated production processes just on following items will make it possible to considerably reduce production output of specialized production units. Thus, the use of 7 million  $m^3$  of crushed rock from overburden rock of the Seligdar deposit will make it possible to stop mining thereof at specialized pits, which will reduce mine material output, taking into account overburden rock, by 14 million  $m^3$ . The use of 2.6 million tons of cement produced in processing of synnirites in accordance with the sintering scheme, will reduce the output of mine material, needed for producing the same amount of cement, by 15 million  $m^3$ , taking into account overburden rock. The output of silicate sand for the glass manufacturing and ceramic industries will be reduced by 4 million  $m^3$  due to the use of Si-stoff and by another 4 million  $m^3$  due to the use of chalk. Besides, transportation expenses for shipping these materials, particularly for shipping cement from the Primorskiy Kray, will decrease.

Integration of groups of enterprises that takes into account possible versions of technological schemes will make it possible to considerably increase efficiency of enterprise placement. Results demonstrate the possibility in principle of mutual absorption of waste within the framework of a group of enterprises and of stopping construction of a number of enterprises for production of necessary components for processing raw materials, as well as of efficient utilization of objects of the social and production infrastructure and of achieving high technical, economic and ecological indices.

Assessment of the base of raw materials resources will change considerably. Inefficient for traditional methods of development mineral resources and overburden and enclosing rock can now be included in industrial reserves. Therefore, new problems arise, problems of more detailed studies, both from geological and technological aspects, of not just mineral resources, but also of overburden and enclosing rock.

Integration of mining production processes will be very promising at newly developed territories of the BAM [Baikal-Amur railroad] zone, the Polar Urals etc.). Besides, it is also feasible to use such production organization in already developed regions, by including into the pool of objects under consideration results of prior development of a territory, such as dumps, slime and slag storages and concentrating tailings.

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PHASE AND CHEMICAL CONVERSIONS IN ALKALINE THERMOCHEMICAL BENEFICIATION OF  
NORTHERN ONEGA BAUXITE

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA  
METALLURGIYA in Russian No 1, Jan-Feb 87 (manuscript received 23 Oct 85)  
pp 53-57

[Article by Zh. D. Zinkevich, N. S. Malts, N. I. Kobova, V. L. Rayzman and  
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Magnesium and Electrode Industry]

[Abstract] Studies were made of the physical and chemical characteristics of bauxite and concentrate samples following treatment at 1050-1100°C for 30 minutes in order to produce more complete information on phase conversions during thermochemical alkaline beneficiation of small (1-2 mm) fractions of bauxite. Samples were treated in a 16-meter rotating industrial furnace at 860-1100°C. The mineral components of the boehmite-gibbsite-kaolinite bauxite underwent the same phase conversions as the individual minerals, with gibbsite and boehmite sequentially converted to  $\gamma\text{-Al}_2\text{O}_3$ ,  $\delta\text{-Al}_2\text{O}_3$ ,  $\theta\text{-Al}_2\text{O}_3$  and  $\alpha\text{-Al}_2\text{O}_3$ . Kaolinite was converted to metakaolinite beginning at 500°C and to  $\gamma\text{-Al}_2\text{O}_3$ , mullite and cristobalite at 900-1300°C. With standard alkaline treatment the roasted mullite went over to the concentrate with no changes. The optimal roasting temperature is 950-1000°C, providing maximum extraction of  $\text{Al}_2\text{O}_3$  from the concentrate with autoclave leaching (88%). Most of the chromium oxide is not oxidized during roasting and remains in the solid phase during subsequent hydrochemical treatment. References 3: all Russian.

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